The
GEOGRAPHICAL JOURNAL

Vol LXXXVIII No 5 R.G.S. *November 1936*

BOTANICAL AND GEOGRAPHICAL EXPLORATIONS IN TIBET, 1935: *A paper read at the Evening Meeting of the Society on 20 April 1936, by*

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TOWARDS the end of April 1935 I left Tezpur in Assam, and early in May reached the inner valleys of the Assam Himalaya. The climate here at 6000 feet is warm temperate, and the rainfall moderate, with long winter drought. Consequently the dense rain forest of the outer slopes is replaced by open forests of Oak, Pine, and Rhododendron.[1] Travelling leisurely over the hill ranges from one tributary of the Bhareli river to another, and halting here and there to explore the rich flora more fully, I reached Senge Dzong on May 28 (see Folding Map at the end of the *Journal*). I was now on the Se La range, which separates Assam from Mönyul, and still awaiting a permit to enter Tibet. At last, permission having been granted, on June 3 I was able to cross the Se La, a pass about 14,000 feet high. The monsoon had just broken. For the next few days I followed a new route, and crossing four more passes, each one higher than the last, had a hard struggle through rain and snow. The alpine flowers however compensated for any discomfort. From Senge Dzong to the Tibetan plateau, the country is lofty but deeply eroded, sparsely populated, and entirely uncultivated. The inhabitants are Mönba, and live on their herds; all grain is imported. Both men and women wear close-fitting, saucepan-shaped, black felt hats, something like those worn by the Persian peasants. Men's hats are distinguished by four short tails twisted from the rim: women's hats are fringed with tails. The women also wear ropes of immense amber beads hanging from their ears.

The first pastoral village I reached was Luguthang (or Lungdang) a small settlement of cold stone houses huddled together on a steep slope, above the tree line. The maps show Luguthang on the Mago chu, but this is incorrect. A high range called Zabu Pu divides the Mago river from the Lungdang Shung chu, which latter rises only a short distance above the village and flows independently to the Tawang river. Crossing this range by the Truker La, a rocky pass of about 16,000 feet, still under snow, I reached the Gorjo chu,

[1] *Pinus excelsa; Quercus Griffithii: Rhododendron arboreum* principally.

which has its source amongst the snow peaks of the Assam Himalaya. Thence crossing the low Chera La, a very steep descent brought me to the Dungma chu, and to Mago. Mago consists of two herd's villages, Dyuri and Nyuri, meaning left hand and right hand respectively, in allusion to their being situated one on the right the other on the left bank of the Goshu chu, which here joins the Dungma chu. The combined river rushes into a gorge, and about a mile farther on is joined by the Gorjo chu. There is no path down the Dungma chu from Mago. It may be noted that the names Dyuri and Nyuri are reversed according to our reckoning; Dyuri being on what we should call the left bank. The two villages together are known to the outside world as Mago. Captain Sherriff and Mr. F. Ludlow were here in 1934. Colonel Bailey and the late Major Morshead visited Mago in 1913, and later it was visited by Neville. The altitude is 11,800 feet (Bailey). Most of its trade is with Dirang Dzong, a large village in the valley below Senge Dzong, but reached by a different route from the one I followed *via* Luguthang. Just above Mago is a hot spring, the water, which smells strongly of sulphuretted hydrogen, bubbling up from under a rock at so high a temperature that it is impossible to hold one's hand in it. Nevertheless several species of Alga flourish. The local people have not troubled to build a bath, nor do they make any use of the water, either for medicinal or ablutionary purposes.

Beyond Mago there are no villages until the plateau is reached, though the herdsmen migrate in summer to a small hill station called Chunak—Black-water, so called from the black slate mud with which a glacier stream is charged. The houses though small are solidly built of stone, but are only occupied between June and October. Other smaller summer villages are Chumba and Lap, the last-named at an altitude of about 14,600 feet.

Continuing my journey northwards, I crossed the main Himalayan range by two high passes, the Tulung La and the Pen La, on consecutive days. Both are over 17,000 feet. After crossing the Tulung La, I left the forest region behind me and entered upon the dry treeless plateau. From the Se La to the Tulung La, the country showed every sign of intense glaciation, though I saw only a few small glaciers. North of the Pen La however there is no trace of glaciation.

On June 11 I reached Karta. There is a small monastery with hovels clustered round it, and a picturesque *chorten*, called the *labrang* (literally, office). Big houses, interspersed with ruins, are scattered over a shelving gravel terrace between two deeply sunken streams, the Tak chu from the Pen La, and the Hlanga chu from the east. These streams unite immediately below Karta, and are the true sources of the Subansiri, which thus rises at the extreme western end of the Assam Himalaya. Looking down the valley from above Karta, a fine snow peak 22,713 feet is seen to the east. I now found myself in a very arid region. All crops are irrigated, the water being brought from a distance of several miles. At this season the fields were brilliant yellow with mustard, and the irrigation channels blue with a charming "Sibirica" Iris. Trees—Poplar and Willow—grow only where they are protected from the wind and spoliation. Down by the river, in sheltered spots are Hippophäe trees. There is a sort of country club out in the fields, surrounded by a wall, behind which grow trees and flowers. Here I stayed two nights. Continuing

northwards I reached Tongme Gompa where the Loro Karpo chu from the west joins the Loro Nakpo chu, to form the Loro chu. The Loro Karpo chu flows eastward, parallel to the Himalaya, in a wide stony valley, but was now almost dry; we were across it before I realized it was a river at all. Most of it is drawn off to irrigate the crops at Tongme Gompa, but for two or three months there is more water coming down. I now turned east down the wide valley of the Loro chu. There is much cultivation here, and by the river dense thorn thickets of sage green Hippophäe; but the valley soon narrows to an arid gorge, and these fleeting signs of fertility disappear. About a mile east of Tongme Gompa is a *stupa* shaped rather like some of the pagodas in Burma; and across the valley is a fine view of the western end of the Assam Himalaya. I was much struck by the contrast between the large size of the valley here, which was both broad and deep, and the small size of the river. Farther west, the valley grows larger as the river shrinks. Formerly the valley was filled with gravel and a series of terraces show where the river flowed when there was more water in it. This present misfit is characteristic of many of the plateau rivers, and is accounted for by the gradually disappearing glaciers which feed them. In 1924 Lord Cawdor and I, travelling south from Tsetang to Tsona Dzong, had crossed one of the headwater streams of the Loro chu. It was the depth of winter, but even so the contrast between the wide stony valley and the paltry stream which flowed through it was notable.

I reached Chayul Dzong (or Chadze) on June 19, a squalid village of hovels in an arid valley, harassed by a perpetual wind. The monastery is worthy of a better background. This was to be my base, but a glance was enough to convince me that few plants grew on these hot dry rocks. Looking eastwards down the gorge however I saw high forested ranges muffled in cloud day after day, so Chayul Dzong was not far removed from a more genial climate. There was more life down by the river than might have been expected in so dry a region. Birds were plentiful in the Hippophäe thickets. I noticed hoopoes, chough, wagtail, kingfishers, rose finch, partridge, babbler, doves, rock pigeons, and several smaller birds. Along a low stone wall built to train the river, voles were common; and in a small pond I found frogs. Between 11,000 and 14,000 feet, it is only necessary to water the ground and almost anything will grow. Irrigation however is difficult in the deep main valleys, and so most of the population live in the higher valleys, above 12,000 feet.

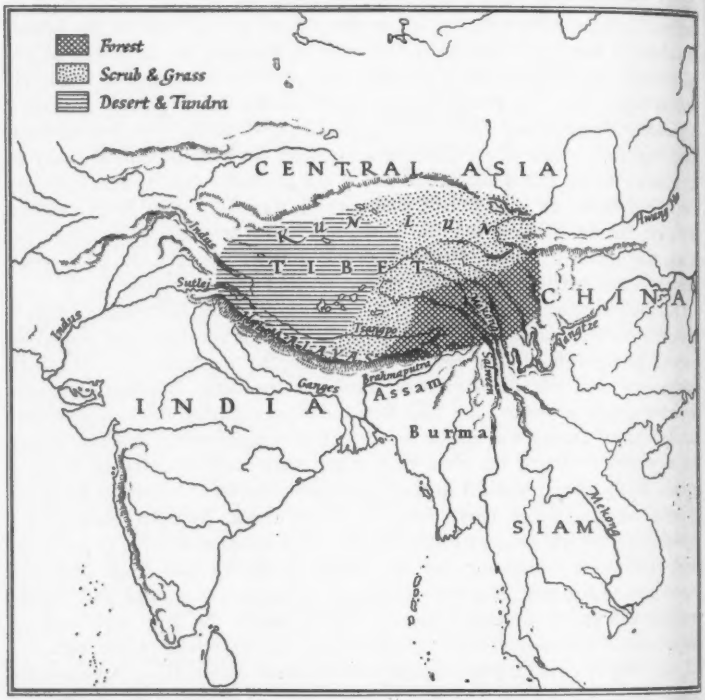
I was now in that extensive region of Southern Tibet, lying between the Assam Himalaya and the Tsangpo through which Colonel F. M. Bailey and the late Major Morshead had passed during their journey of 1913. Morshead had discovered that the Subansiri rose behind the Himalaya as far west as the 92nd meridian, and that it was the headwaters of this river which drained the plateau here.[1] It was not difficult however for the most part to avoid their routes. To naturalists it is virgin territory, so that as a botanist it did not matter if I followed in the footsteps of the pioneers. The only map I had with me was a copy of Morshead's reconnaissance survey on the 1/8-inch

[1] This had long been suspected, owing to the great size of the Subansiri in Assam. In the General Report, Survey of India, 1877–78, Captain Woodthorpe wrote: "That the Subansiri rises behind the high snowy peaks seen from Tezpur I think very likely from its size and velocity. . . ." Bailey and Morshead proved the truth of this surmise.

scale, which proved invaluable. This I used to check my own traverses across unexplored areas south of the Tsangpo.

I stayed only a few days at Chayul, and then set out on what I intended to be a month's journey.

My first march eastwards, down the Loro chu to Trön, was a long and hot one. Just above the Nye chu confluence, the road crosses to the right bank, and so continues for several miles. At the portals of a savage looking gorge, where the Loro chu appears to be (and probably is) entering the Himalayan range, the road returns to the left bank and becomes difficult. First it ascends



the cliff by means of a built-up path and rock ledges. Finally a vertical ladder, very awkwardly placed, and some 40 feet high, has to be climbed; luckily it is a real ladder, not just a notched pole. At one time there was an easier road at the foot of the cliffs; but the bridges are all broken, and the people have not troubled to repair them. In the evening we reached Trön, a village on both sides of the valley. Like Rima it is, or was, a penal settlement. A stone tower, in the base of which is a dungeon 12 feet deep, stands on the brink of the precipice. Condemned criminals used to be flung from the tower, but this punishment is now obsolete, though the dungeon is used. In winter jungle tribes come up the valley for salt. Some go to Sanga Chöling—these are called Chachu Or, and some to Chayul Dzong, these are called Chachu Kung; but

probably they are both clans of one tribe, the people who in Assam are called comprehensively Dafla (or possibly Aka). When the snow melts on the Himalaya, they also come over two passes, the Kashung La, south-east of Trön, and the Hla La, almost due south. Both passes are on the headwaters of the Kamla river, a large tributary of the Subansiri, which rises on the southern slopes of the Assam Himalaya. The salt is not a local product, but is brought from interior Tibet down the Nye chu. Before being sold to these Chachu (or Lopa) it is mixed with the dried sprigs of a common alpine cushion plant (*Arenaria polytrichoides*). This looks at first blush like sharp practice, but it is not. The Arenaria absorbs the water taken up by the hygroscopic salt; otherwise the Lopas, by the time they got back, would have none left, it would all have deliquesced. In exchange for the salt, the Lopas bring cane, skins, condiments, such as chilis and star anise (Illicium), and rice. Inter-village warfare is common amongst these savages, and whole villages disappear; but they give no trouble to the Tibetans, on whom they are entirely dependent for salt. It is unlikely that the Tibetans will penetrate farther east by the Subansiri headwaters.

From Trön I crossed the range to the north by a high and steep pass, the Drichung La, reaching Charme on the second day. The path follows a ridge instead of a valley, and we took yak transport. Above Trön we quickly reached a moister zone, and found many beautiful alpine flowers, including the rare anemone-like *Adonis brevistyla*, and *Primula Roylei*. From our first camp on the ridge above Trön we had a wonderful view into the yawning chasm of the Loro chu, buttressed by the spurs of the Himalaya. I also noticed a glacier west of us, on the same range. The Drichung La is very steep on both sides. Near the summit I found a new species of primula (*P. consocia*) and the charming dwarf *Meconopsis bella*. On the north side we descended a glaciated valley, but soon left it for a ridge. This was the first authentic signs of glaciation I had seen since crossing the Pen La. The Drichung La is about 17,000 feet.[1] From Charme I followed up the river to Sanga Chöling, the only considerable village in this part of the country. There are two fine monasteries. I was well received by the officials, one of whom had travelled with Sir Charles Bell some years previously. When I said I was a friend of Sir Charles' he could not do too much for me. I easily obtained permission to continue my journey to Tsari, a district I was anxious to visit for botanical reasons.

On the hot dry cliffs of the Char 'chu were great numbers of ugly black lizards. They attain a foot in length, and are found up to 12,000 feet. This lizard is common also in the dry Tsangpo valley, but does not occur beyond. In the very similar Salween valley (similar as regards its arid climate) a totally different genus is found. From Sanga Chöling I crossed the Cha La, 16,610 feet. In the narrow ravine above the Char chu, I was surprised to find forest, or at any rate trees (Conifers) growing on the cliffs, but we soon reached the

[1] I had no instruments with me. The heights given therefore are guesses, and I am fully aware of their crudeness, but a considerable experience of Tibet gives me some confidence in guessing. Moreover I had two useful standards of comparison—the nature of the vegetation, which to a field botanist is eloquent, and the heights of neighbouring passes over the same range, as given on Morshead's map.

alpine region, and a wealth of beautiful flowers. Looking back, I saw a fine snow peak, with one large and two small glaciers on the range south of Sanga Chöling; probably near the Le La, which is on the main route to Chayul Dzong. We reached Chösam, the first village in Tsari, in two days. After crossing the Cha La, although still within the Subansiri basin (the Tsari river flowing south-east) I was really over the second of the two fold ranges which lie between the Assam Himalaya and the Tsangpo. Takpa Shiri (commonly called Tsa Ri) is not, I believe, on the Himalaya but on the southernmost of these two lesser ranges.

Chösam, although a considerable village of stone houses, has no cultivation; it is another herd village. Not only is the Tsari valley, from Chösam eastwards, a typical ice-worn valley, but on the Takpa Shiri range immediately to the south are several short hanging glaciers. At Totsen the valley widens out into a great marshy meadow, now gay with millions of yellow *Primula sikkimensis* and violet iris. This is clearly a silted-up glacier lake basin. We covered the long march—about 18 miles—to Chickchar in a day; and I found the flora of this moist valley very similar to that of Tumbatse. Adonis was abundant. *Meconopsis betonicifolia* occurred lower down, where forest began, but was much less common than either *M. paniculata* or *M. simplicifolia*. Here I found the unknown *M. argemonantha*.

Chickchar boasts almost as many monasteries as houses. It exists by and for the pilgrim traffic. Although in ordinary years pilgrims are comparatively few, over fifty passed during the three days I spent here. Every twelfth year there is a special pilgrimage round Tsa Ri. The Tsari valley is much wetter than the other valleys to the south, lying just behind the Assam Himalaya in approximately the same longitude. It differs from them also in being ice worn instead of water worn. It is tempting to assume that the great glaciers have ploughed wide furrows through the ranges, thus letting in the moisture-laden winds from Upper Assam. But a moment's reflection shows that this theory is untenable. It was those same moist winds which nourished and kept alive the glaciers; and still do so to some extent. A small glacier hangs right over Chickchar. Some other explanation for the wetness of the Tsari valley must be sought. Pheasants are absurdly tame at Chickchar, and come right out into the open. They are never molested. A magnificent cock Harman's pheasant (*Crossoptilon harmani*) used to come out every morning within 50 yards of the house where I stayed, and call truculently. One afternoon (July 4) I walked right into a family of Harman's pheasants, the chicks, which were about two weeks old, running squawking in all directions; but the old birds made hardly any attempt to get out of the way. Even more tame are the grey rock pigeons.

From Chickchar I went some miles down the forested valley to the last Tibetan, or rather Tibetanized, village called Migyitun. Below Chickchar the valley changes its appearance, the river falling very steeply, broken by terrific rapids. Pilgrims to the sacred snow lake Tsoga near Migyitun stay in a sort of monastic inn. A large glacier torrent from the snow peaks to the north-east enters the Tsari river here. It is a long day's march eastwards to Tsoga, over three passes. From the last pass, about 17,000 feet—there was snow on it—a fine range of snow peaks, their glaciers entering the lake below,

Gorge of the Loro chu seen from above Trŏn, Assam Himalaya in cloud

Meadows at Chuchul.

came into view. There is nothing very remarkable about Tsoga however, which is an ordinary glacier lake, half filled up. The water is not even blue, as the mud has no time to settle before the water flows out through a valley to the Tsari river below Migyitun. But the view of it from the pass is certainly impressive. My coolies having acquired merit by walking round the lake, we returned to Migyitun and marched up the valley again half-way to Chickchar. From this point I turned north, with the object of reaching the Tsangpo by a new route. Crossing the Bimbi La,[1] an easy pass not much over 15,000 feet, we descended to a considerable river, flowing in a deep valley from the south-west. Towards the north-east, down stream, I noticed a snow peak with glaciers, while immediately north of the river were more snow peaks. A day's march down the valley brought us to a village called Ken, or Sumbatse. In the foreground, across the river, a conspicuous rocky ridge divided it from another equally large river (Ka chu) to the east. We were again in a drier region, characterized by rosette and fleshy leaved plants and few trees; but it was the height of summer and there were many beautiful flowers, such as blue larkspur and *Dracocephalum*, pink *Androsace*, and violet *Onosma Hookeri Wardii*.

On July 14 a half-day's march brought us to Kyimdong Dzong, only a few miles from the Tsangpo. Here I was welcomed by a grave-looking courteous *dzongpön*. Instead of going straight to the Tsangpo I decided to continue my explorations, and to cross the Lang La, and reach Lilung. Turning eastwards again up a cultivated valley, I crossed the pass at its head, and came to the sources of the Lilung chu. The weather was very wet, which ruined the view; but I could see glaciers on the snow peaks above Ken, part of the Himalayan range, to the south-east of the Lang La. The Lang La, though steep on both sides for the last 1000 feet, is not a difficult pass. A long march down the alpine valley brought us to Nepar, where the stream from the Lang La joins the larger Ne chu. Though we were not in a specially wet region these alpine valleys north of the Himalaya get their share of rain in summer, and are vivid with coloured forms of *Primula alpicola*. It was interesting to observe that *Primula Florindae* had now definitely replaced *P. sikkimensis* in bogs. East of Nepar is a sacred mountain of no great height, called Trashi Gola, in the district of Tsari Sama. A few hours' march down the Ne chu brought us to Barang Shiga and Molo, where another large stream, the Sama (or Lagong) chu, joins in to make the Lilung Chu, which is the largest tributary the Tsangpo receives on the south bank for very many miles. From Barang Shiga to Lilung on the Tsangpo is a long march by a rough track. It took us ten hours. About 8 miles from Lilung the slates and sedimentary rocks of which these two fold ranges we had crossed are built, at last gave place to granite. On the cliffs *Lilium Wardii* was just coming into bloom, its lovely pink flowers scenting the path. This is the farthest west it has been recorded, and probably its western limit.

The gorge of the Lilung chu is well forested with Picea and Larch; lower down, large trees of *Quercus Ilex* appear. As the Tsangpo is approached

[1] Kinthup crossed the Bimbi La in 1883, whence Totsen (Tsoga) village was reached, "where there is a monastery and a big lake . . ." It is unlikely that this refers to the Tsoga above Migyitun. Records of the Survey of India, Vol. VIII, Part II.

however mixed forest gives place to almost pure Pine forest (*P. tabulaeformis*). From Lilung eastwards even the dry Tsangpo valley is fairly well wooded, forest presently approaching the river bank, and even bed; but there are still sand dunes, partly clothed with sand-binding grasses. In places the valley is deliciously green with crops, which need no irrigation. The road down the Tsangpo—as in 1924, I kept to the right bank—is long and winding, with many detours to cross tributaries. It is surprising that the Tibetans do not make use of their magnificent waterway, which for miles, though swift, is unbroken by rapids and quite fit for boats. Lopas, who come over the mountains to work in the fields, would be available for hauling boats upstream, at any rate during the high-water season. From Lilung to Tsela Dzong, a distance of 60 miles, there is not a single impediment to navigation. One is forced to the conclusion, rather borne out by experience, that there is no serious traffic in the Tsangpo valley.

On July 22 I reached Tsela Dzong, where I stayed three days. Eleven years had brought no change here. I visited some of my old haunts, where in 1924 I had collected many fine plants—a rather melancholy proceeding. I found here the striking yellow-flowered *Morina Coulteriana*, which grows also round Simla. These are not true alpines, but plants which grow at comparatively low altitudes. The main valley for some miles above the Gyamda chu confluence is fully 2 miles wide, and the river, which is extraordinarily placed, corresponds. Even at this season of high water there were islands in midstream, and sand dunes at the confluence. The Tsangpo valley east of Shoka is obviously glaciated; and when looking down it, with the river out of sight, I had the curious illusion that it slopes to the west. From Tsela Dzong I saw the snow cone of the Namcha Barwa over the Temo La range, not often visible at this season. Looking towards the north-east—that is in the direction of the river's course—I was aware of a great arc of snow peaks beginning with Namcha Barwa and its satellites in the south, continuing through Gyala Peri and Markandro and the snow peaks above Lunang, and curving through the great range above Tongkyuk and the Po Yigrong.

Sir Sidney Burrard stated some years ago that there was conclusive evidence that the Tsangpo formerly flowed in the opposite direction, that is from east to west.[1] He based his argument on the number of its tributaries which flow in a direction contrary to the main river, and cited the Kyi chu, Nyang, Rang, and Shang. To these may be added the Kyimdong chu, then unknown. But Burrard did not know quite what to do with his river when he had transferred it to western Tibet. He was anxious to dispose of it through the Himalaya. If however it was a smaller river then than it is now, it may quite easily have lost itself in the Tibet lake basin, then much larger than it is to-day. The difficulty is that if the Tsangpo flowed westwards the Gyamda river must almost certainly have done the same; and though there is no a priori reason why it should not have done so, neither is there any direct proof that it did. The great lake-like expanses of the Tsangpo valley at Pe and at the Gyamda river confluence, the arrangement of the great snow peaks in an arc from north to south, the westward flow of the Namcha Barwa glaciers, and the

[1] 'A Sketch of the Geography and Geology of the Himalaya Mountains, and Tibet,' by Colonel S. G. Burrard, F.R.S., and H. H. Hayden, B.A., F.G.S. (First Edition).

immense gravel terraces and moraines at Kyikar, thinning out westwards, are facts which lend colour to Burrard's theory.

In 1924 from a hill-top near Tsela Dzong I had seen what appeared to be a great range of snow peaks to the north distant perhaps 50 or 60 miles. Later, from another hill-top even better situated, Cawdor and I had obtained an extensive view of this range: for range it certainly was, not a few isolated peaks. We made two attempts to locate it more exactly, in August, and December, but without much success. It happened that the summer of 1924 was unusually wet, and although we caught sight of snow peaks and glaciers from the Nambu La and Pasum Tso, more or less where we supposed the range to be, we were never very sure of its location, extent or direction.[1] I now decided to make another attempt, and took the road to Tumbatse, which had been our base in 1924.

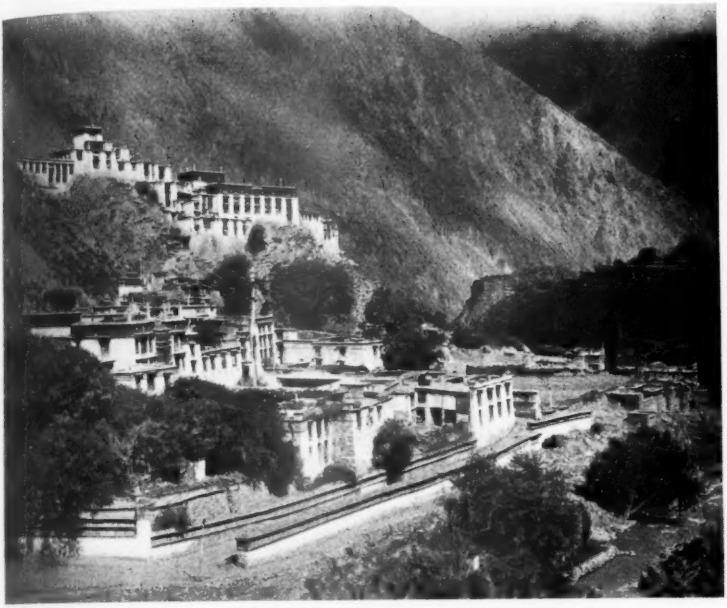
From Temo Gompa I crossed the Temo La in fine weather and from the Rong chu again saw snow peaks to the north, which I reckoned to be not more than 30 or 40 miles distant. As Tongkyuk is almost exactly 20 miles from Tumbatse, I would on arrival there at least be "warm"—as children say. At Tongkyuk I was met by a smart military-looking *dzongpön*, who had arrived from Lhasa only a few days previously on special duty. Formerly, he told me, he had been Chief of the Lhasa Police. He was shortly going to the Po-Yigrong, and when I expressed a wish to go to Showa, he discouraged the idea, saying that Pome at this time of year was an unhealthy place—which was likely. However he said I might go to the Pasum Tso or to the Po-Yigrong if I liked. This was just what I wanted, and after a day's delay at Tongkyuk I started for the Po-Yigrong.

Two years previously the Tongkyuk river had come down in flood, carrying away the road and every bridge, and tearing out the sides of the valley 30 or 40 feet above the normal level. It had not done much damage—Tongkyuk itself is built on a rock, 200 feet above the river—because there is not much here to damage; but it must have been a wonderful sight while it lasted. This district on the edge of Pome is very sparsely populated. The people are not true Poba, nor do they resemble the people of the plateau. They call themselves simply Rongpa (literally, valley-dwellers). While we were here numbers of Kampa pilgrims on their way to Lhasa passed through Tongkyuk. They had come down the Yigrong gorge and over the Sobhe La in order to reach Temo Gompa, working in the fields for a few days at each village through which they passed in order to earn their keep. In the last days of July I started up the Tongkyuk valley with ponies and porters. Two miles above the village of Paka, where a large glacier torrent flows in from the north, we camped at the mouth of a comparatively small stream rushing through a narrow glen, and next day we began the steep ascent through the forest to the Sobhe La. One would have supposed that the wide valley of the Paka chu was the obvious route—indeed I had been told as much in 1924. Actually the Paka chu is blocked at its head by glaciers, and the path up the next valley might easily be missed. Above the forest we came to meadows of tall flowers, amongst which two species of wild onion (*Allium*) were conspicuous. One of these had handsome heads of purple flowers. I had expected to find the

[1] *Geogr. J.*, February 1926.

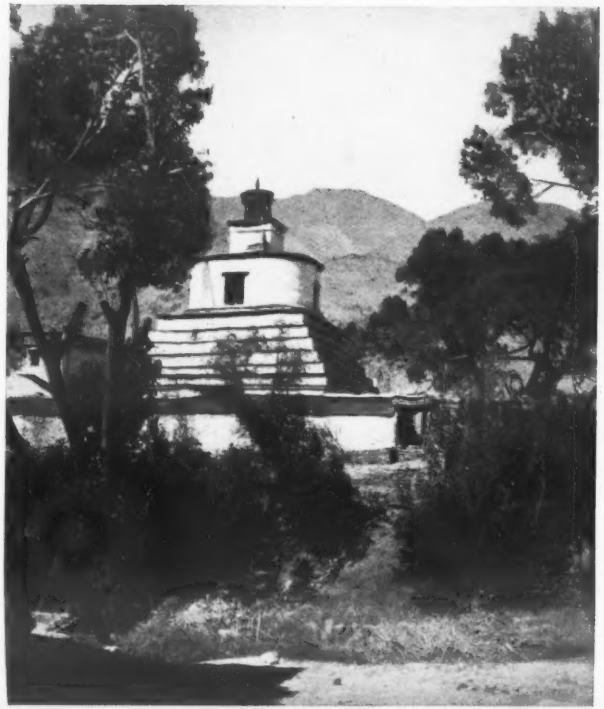
Tibetan climate suitable to lilies, and hoped there would be many species of those fine plants. Actually there are only two, *Lilium giganteum* and *L. Wardii*. But the peculiar Tibetan alpine climate has helped to evolve two endemic lily-like genera, namely *Notholirion* and *Nomocharis*. Instead of lilies, another genus of bulbous plants, namely *Allium*, shows considerable development in Tibet; and in the course of this journey I found no less than ten species, several of them beautiful plants.

By the afternoon of August 1 we were in a broad glaciated valley, beneath the snow peaks. The last doubt vanished. In front of me was the snow range I had come to seek. Our little camp was girdled by peaks and small hanging glaciers, the farthest 3 or 4 miles distant. The evening was fine, and we could see the pass at the head of the valley, between two snow peaks. The dawn was suspiciously clear, every peak and six glaciers being visible. However I expected to reach the pass within three hours, before the clouds came up. Actually it took us four hours of hard going over moraines; the last few hundred feet were very steep, and before we reached the pass clouds had gathered round the snow peaks. We looked over into a valley full of mist, but the veil lifted momentarily, and through a dark ravine I caught sight of the Po-Yigrong to north-north-east steeped in sunshine, with cultivation on the far side, and two lofty snow peaks beyond that. From here the river looked rather like a lake. The Sobhe La is certainly over 16,000 feet, and is a difficult pass; nevertheless it is much used, especially by pilgrims from Pome on their way to Lhasa during the summer. The south side, as I have said, was steep, but the north side was precipitous, and a hard snow slope at about 70° did not make it easier. A cautious climber would surely have roped his party here; but the Tibetans cheerfully traversed diagonally across the snow face, where pilgrims had already trodden a narrow track, though a slip meant certain death. The descent was more arduous than the ascent had been, and extraordinarily steep for 1000 or 1500 feet. We met a small party of pilgrims on their way up. They prefer this difficult short cut to the two days' journey down the Po-Yigrong, and thence up the Tongkyuk river, in the rainy season. A woman was carrying a tiny baby in a basket on her back! At last the slope eased off on to a grassy shoulder overlooking a deep gulley filled by a glacier from the eastern peak above the Sobhe La. Descending the lower part of the glacier we reached a very boggy meadow into which four glaciers discharged. No less than three alpine Rhododendrons were in full bloom here. On a slight mound in the midst of this marsh was a herd's hut. We squelched through the marsh for half a mile, crossing several quick streams. A large glacier from the western peak almost completely blocked the exit from the marsh, and the combined streams, squeezed between the end of the moraine and the cliffs on the other side, rushed out of the meadow and fell with a roar into the forested valley below. The path continued very steeply down the moraine, now clothed with shrubs. After descending about 1000 feet we crossed to the right bank of the turbulent torrent, and continued the steep descent through Rhododendron and Fir forest. After crossing several glacier torrents we camped at dusk in a clearing where grew sheaves of the beautiful purple lily called *Notholirion campanulatum*, with *Astilbe*, *Rodgersia*, and other big-leafed woodland herbs. We reached the broad valley next day,



Sanga Chöling

Dirang Dzong



The 'labrang,' Karta

Bridge-building in the gorge of the Yigrong

passing from mixed Conifer to Tsuga forest where epiphytes smothered the trees, and finally to forests of *Pinus excelsa*. This valley or plain, called simply Po-Yigrong,[1] is 3 to 4 miles long, and a mile wide, clearly a filled-up glacier lake basin. We turned west and halted at the village of Temo Chamna, close to the river. On the left bank are several villages and a *dzong* called Tongbe, but no *dzongpön*, the district being under Tongkyuk. At the head of the plain is a small monastery, Samling Gompa. The size and speed of the river surprised me. It flows from west-north-west almost due east for about a mile, then turns more to the south; the south-east end of the plain was hidden from view by a spur. At the north-west end a large tributary enters, flowing through a gorge from a group of snow peaks. The plain is in fact enclosed by snow mountains, the glaciers from the northern range being visible from Temo Chamna, as those around the Sobhe La would be from the other bank; only the view from there would be even finer. What a magnificent base this plain would make for a well-equipped expedition to explore thoroughly the difficult and mysterious Po country!

To the north, a group of high bare granite peaks like those seen from Shugden Gompa in 1933 was conspicuous; and towards the south-west was a similar group, continuing the range in that direction; but these are only outliers of the great snow range. The fact that there are snow peaks, or rather a snow range, on both sides of the Po-Yigrong, suggests the possibility that we are really dealing with two distinct ranges. I can hardly believe that the Po-Yigrong has cut a 100-mile gorge diagonally across a single axis. If Namcha Barwa and Gyala Peri stand on separate ranges, as they must unless we believe the Tsangpo has cut a diagonal gorge across the Himalayan axis, the snow peaks N. and S. of the Po-Yigrong also do so. The main range with the highest peaks certainly lies south of the river. Nevertheless there is a chain of snow peaks parallel to, and north of the river also; and while it is permissible to make suggestions as a result of what I saw, obviously no final pronouncement on so intricate a problem can be expected as the result of a rapid pioneer journey. The river was strewn with dead timber, whole trees sticking up out of the sandy bottom. Several short coracle-like dugouts were drawn up on the bank, and fishing nets were spread out to dry. Whenever a big flood comes down part of the plain, more particularly on the flat right bank, is inundated. It was now under crops however and the corn was already ripe. The altitude of Po-Yigrong cannot be much over 7000 feet, and the temperature in my tent at 4 p.m. was still 77° F. Cattle are kept.

On August 4 we started up the Po-Yigrong, and crossing a very large torrent, we quickly reached the end of cultivation. Ascending a pine-covered moraine we entered a deep forested gorge. Almost immediately we began to climb, and from this point to Talu we caught only an occasional glimpse of the river. But we heard it. When we did see it, it was a furious mass of foam;

[1] The Po Yigrong was discovered by Bailey and Morshead in 1913. Earlier maps of the Tsangpo bend based on Kinthup's journey, though showing a possible Po-Yigrong, are so inaccurate that the river can hardly be said to exist. Being unable to cross it at its junction with the Po-Tsangpo, they marched two days up the right bank and crossed it at the southern end of the same plain which I reached at its northern end. I heard it always called Yigoong, or Yigung, though occasionally the "r" was just sounded. Naturally, I have not altered Bailey's spelling.

Bridge-building in the gorge of the Yigrong
The 'labrang,' Karta

there appear to be vertical falls, though of no great height, between Talu and the plain. The walls of the gorge are absolutely sheer, and on the north side many hundred of feet high. We passed through forests of magnificent oaks and other broad-leaved trees, with Tsuga and a big tree Rhododendron as we got higher. The next two nights we camped by large glacier torrents which came rushing in from the south-west, and therefore had their sources near the Sobhe La. I had caught a glimpse of snow peaks in this direction from Temo Chamna, but the fact that three great torrents entered the Yigrong within a few miles of one another indicates that there is a group of big peaks just west of the pass. Two high-level terraces afforded good camping grounds by the torrent the first night; but the thick forest which covered them made it very confusing to remember which terrace was which, and wandering away from the camp I had some difficulty in finding it again. On the third morning we stood on a cliff and looked down on another opening in the valley, with intermittent cultivation for over a mile on the left bank, and three villages, numbering at least fifty wooden houses. Below us a rope bridge spanned the river. The crossing took some time. Had the river been a foot higher we could not have crossed at all. Even here the current was running at a good 10 knots. We continued a short distance up the left bank and halted at the village of Talu. The whole valley with its three villages (there are few houses on the right bank) is called Tage. The weather was wet and cloudy and I was not sorry to halt here for a day while porters were being collected for the next lap.

On August 8 we continued our journey, soon reaching the head of the valley and plunging once more into a forested gorge. Just before entering the gorge we crossed a big stream from a snow peak called Tamchokpa to the north-west; there is a village of the same name a day's journey up the valley, but no through route. We now began to see snow peaks on both sides of us quite close, and presently we passed a steep glacier on the right bank, whose foot was within about 1500 feet of the river. The forest here was composed almost entirely of Pines (*P. excelsa* and *P. tabulaeformis*) and Rhododendron; but on the sheltered side Tsuga was also common. About 4 miles from Talu we reached the small village of Ba, above which the river, making an S bend between snow peaks, again becomes turbulent. That night we camped at the foot of a great water-worn granite cliff, where the river was in frantic turmoil, leaping down a steeply sloping bed choked with huge boulders.

The next day's march was not unlike that of the previous day; but in the evening we reached a small village opposite a glacier. The pine forest suggested that we might be approaching a drier region, and certainly I had no reason to grumble at the weather, as we had almost as many fine days as wet ones. But here I found *Rhododendron megacalyx*, which is rather indicative of a wetter climate. The flora was indeed very rich, and the great number of species kept me fully occupied. It is a fact of considerable interest that the flora of the southern Himalayan slopes in the Simla region and farther north-west, crosses the great range somewhere to the west of Sikkim, to reappear on the northern Himalayan slopes in Eastern Tibet. Not only so, but this same flora spreads north of the Tsangpo, and is found on the range I was now exploring. Eastwards it extends into the mountains of China.

August 10 was wet and we did not get very far. First to a small village called

Boyu, where we changed porters; then on to a larger village called Shonggyi, at the junction of a big stream from the north. Shonggyi stands opposite to a fine snow peak and glacier nearly due south which descends very close to the river. The north valley is strewn with large erratics, and up it I could see snow peaks and glaciers. The snow peaks north of the river are farther away than those to the south, and the glaciers have retreated farther. The gorge of the Po-Yigrong seems to be entirely water eroded; it shows no evidence of ice action, but the lake beds of Yigrong and Tage are proof that at any rate glaciers reached the main valley from both sides. They may have flowed down it. The river is degrading its bed very rapidly on the steep pitches between the levels, and we passed bare granite cliffs, now high and dry and under gravel and conglomerate beds which at no remote date must have been scoured by it. Obviously all traces of ice action would quickly be worn away. One pictures a chain of lakes connected by falls or steep rapids flowing from the ends of glaciers, like the Pasum Tso lake chain, part of which still persists.

Next day after a short march through a gorge staggered like a sap, and a long climb up to a shoulder, we reached the big village of Ragoonka on a sloping terrace, which undoubtedly marks the level of an older glacier valley. The shoulder is an ice shelf left intact by the river while cutting its bed through the old glacier floor. A small hanging glacier on the rocky range to the north just above the village emphasized this. To south and west the view was very different. Here were great snow peaks rising from the depths of the gorge. The highest peaks and largest glaciers lay to the south. The river makes a sharp bend round the spur on which Ragoonka is built, and is joined from the south by a stream flowing in a very deep gorge between the snow peaks. At the head of this valley is the Ba La, beyond which lies the Pasum Tso. The Ba La therefore crosses the main range; and from Ragoonka to the Pasum Tso is five marches. Both gorges, especially that of the Po-Yigrong, looked absolutely impassable from above. Ragoonka is an important place. The well-built houses, some eighty in number, of timber on stone foundations, stand at the top of the sloping shoulder amongst tiers of cornfields. At the foot of the slope is a wide cultivated terrace, bounded by the river cliffs. I counted a hundred people working in the cornfields, and the total population must be about four hundred. I stayed in a leaky room, one of several round the courtyard of a small decayed monastery. Five soldiers, who had been ordered down river to meet the *dzongpön*, called on me. They were fine upstanding men armed with neglected pre-war rifles. The weather had turned wet and the snow peaks were for the most part hidden in cloud. When we started westwards again on August 13 the rain had ceased. I noticed that the Ragoonka porters carried axes and long coils of new yak-hair rope, and we took on three extra men. Descending very steeply the opposite side of the spur, we reached the river once more and travelled along the bank beneath high cliffs. Glaciers from the southern range petered out only a few hundred feet above the river, and a snow bed in a gully actually reached the water. Under the glaciers the rapids were fiercer than ever. From a spur I had a good view down the gorge to a snow peak opposite Ragoonka. After marching about 7 miles in six hours we camped on a grassy flat beneath high bare granite cliffs. The next day's march began with a stiff climb up the cliff for

1000 feet or more, followed by an awkward descent down ladders (notched poles) and rough going over boulder slopes to the river again. But the gorge was growing ever narrower and steeper, and we soon had to climb again. Now came a very awkward traverse across a smooth granite face, which immediately below fell sheer to the river. How the six round holes had been ground in the hard rock I could not imagine; they would take one's toes, no more, the rest was balance. To a non-climber it was giddy work watching the porters with 40-lb. loads on their backs step nonchalantly across leaning very slightly inwards; giddier work crossing oneself, even with the adventitious aid of a rope! Towards evening we reached the most formidable part of the gorge. The cliffs towered up for thousands of feet, till scarcely any sky could be seen, and they were very bare. There seemed no way either through or over. The rapids were tremendous, and the thunder of them filled the gorge, echoing from cliff to cliff. A hidden path zigzagged up a cleft in the rock, behind a dense screen of bamboo; it brought us to a dizzy gallery built round the face of a buttress. Again I marvelled at the ingenuity of the primitive workmen who had engineered this remarkable road: it was like a scenic railway at a fun city—without the fun. The gallery (of timber) continued for 300 feet, tacked on to a bare vertical cliff, and then we reached firm rock again well inside the portals of this amazing gorge. Two possibilities were now open to us. We could descend to the river again, and if the water was sufficiently low, clamber round the scalloped cliffs by means of a "bridge"; or we could leave the gorge by continuing the climb for some thousands of feet, crossing the mountains, and descending to another river. The latter route was said to be longer by a day; but as the bridge referred to would probably need a good deal of repairing, if not rebuilding, there might be little in it. We decided to examine the river first, and descending once more, we reached the water's edge. The scene was certainly awe-inspiring even for this part of Tibet, where that adjective is apt to be overworked. I could plainly see the tilt of the river bed for some distance; it was like looking uphill. Only at intervals the gradient was broken by an escarpment, or the whaleback of a projecting rock over which the vast volume of water just dropped with a thud, or rose and leapt, or poured round in two girdling streams, as though forced from a hose pipe. Immediately in front rose the overhanging cliff, against which surged great waves. A wooden gallery sloped up the face and disappeared round a corner; the lower end of it hung 12 feet above the water-level, and was reached by a notched log, lashed to some staging. But the staging itself was 30 or 40 feet from where we stood on safe ground, with heaving deep water between. The rest of the bridge had been washed away. We camped close by, cutting out a nest in a dense growth of bamboos, and that evening the Tibetans spun a 100-foot rope of split bamboo. Early next day the bridge building began. Whole trees were felled and by midday we had crossed the gap on sticks, and reached the gallery. Round the corner we found a bay beneath us, the water heaving waist deep against the cliff. Now the bamboo rope came in. Two men crossed the bay with the end of the rope, fastened it to a pole driven into the ground, and men and loads slid down the improvised rope bridge. During the last hours of daylight we made better progress, still hemmed in by huge cliffs, but keeping close to the river. Presently we turned

abruptly north-west, with snow peaks visible to the south-west at the angle again, climbed high up a cliff above violent rapids, and descended to a broad arid valley. The river, now 80 yards wide, flowed tranquilly but swiftly. The contrast was complete: we were out of the gorge. Ahead of us the high, bare granite mountains and wide flat valley, with sand banks dividing the river, were typical of dry Tibet; the wind was both dry and hot. The altitude would be 11,000 or 12,000 feet, not more. I found a striped toad (*Bufo viridis*) in a thicket here. Behind us the river plunged steeply into the bowels of the mountains. Next day we soon reached a rope bridge, and crossing to the right bank presently reached Nyo (Nyöme). Just above the rope bridge, from a deep slit in the mountains on the left bank, the Alado chu peacefully enters the Po-Yigrong from the east; a snow peak was visible.

Had we crossed the mountains from the lower end of the gorge we should have descended to the Alado chu. There is a road up this river which, after crossing the Alado La, joins the Gyalam at Lharigo Dzong. Another road to the west, the one we followed, joins the Gyalam at Laru, a few miles north of Gyamda. The Kampa pilgrims we met at Tongkyuk had come this way from Kam. There is no road northwards other than that up the Alado chu. It is now evident why the Gyalam between Gyamda and Alado makes its big northward arc: namely, to miss the difficult Po-Yigrong country. The chord made by the Laru–Nyo–Alado route is not exactly a short cut, but is certainly used both by traders and pilgrims, as is the route down the Yigrong gorge itself. Nye is a considerable but scattered village, at the west end of a mile-wide cultivated valley, 2 or 3 miles long. There are several villages on both banks, joined by a wooden bridge. The valley is dry and hot, all crops being irrigated—though it poured with rain while I was there. The large houses are built of stone, with wooden roofs, and there is the usual stone-flagged courtyard, surrounded by noisome rooms in which the workers live. I spent the night in the little monastery. Between Temo Chamna and the end of the Yigrong gorge below Nye, the river receives eleven large tributaries on the right, or south bank, but only eight on the left or north bank. The southern or south-western tributaries are for the most part larger than the northern tributaries, proving that here at any rate the main portion of the snow range lies to the south of the river. In this stretch I saw only three rope bridges, including the one at Tage. The first cantilever bridge is at Nye.

Above Nyöme the Po-Yigrong (now called Nyo chu) becomes an ordinary boisterous mountain torrent, rushing between forested mountains. The dryness of Nye is due to local wind; there is plenty of rain in the neighbourhood. Squirrels are common in the mixed forest which fills the valley above Nyöme. The path is rough. Passing through the villages of Tor, and Kongma (where we slept) we reached Nyotö Sama at midday on August 18, and again the valley completely changed its appearance. For the last time it widened out, the forest ended, and the river meandered through flat meadows. The plain was about 2 miles long, and contained several clusters of stone houses with wooden roofs. One village on the right bank of the river stood at the foot of a steep terminal moraine, now covered with trees; the glacier above descended to within half a mile of the plain. But the finest sight of all was the great glacier which descended into the main valley from the south, completely

blocking it. Below the glacier foot was a small lake. That this glacier, reinforced by lateral glaciers, had reached the end of the plain in recent times—probably a few centuries ago—was obvious. Even the terminal moraine at Nyotö Sama which had held up the original lake, was still visible. Thus the Po-Yigrong displays a chain of four basins threaded on a narrow gorge. The topmost basin still contains a glacier, above which is a typical alpine valley with more glaciers at its head. There can be no doubt that the basins are lake basins, and that each one of them contained a glacier at no remote date; probably these glaciers remained stationary for a considerable time and represented the last phase of the glacial period before the final (present) retreat set in. The question then arises: was the entire Po-Yigrong gorge occupied by a glacier some 75 miles long? From what I saw at Ragoonka and Shonggyi, I am of opinion that it was, though as I have already remarked the gorge shows no visible sign of ice action. In this connection however the following points must be borne in mind. The present rate of retreat of the glaciers, whatever it may be, is no measure of the past rate. The larger the glacier, and certainly the lower down it was, the faster it disappeared when once the retreat was sounded. There has probably been a progressive slowing down of the retreat. The alpine valleys would retain their glacial shape and glacial remains long after the lower valley had lost both; and that for three reasons: (1) the alpine valleys are protected by snow, and by the freezing of the streams for six months in every year. (2) They were of course the last to lose their glaciers, which have not yet disappeared. (3) There is no forest, which has a conservative effect and certainly helps to mask the debris of glaciers. Add to this that the links between the chain of lakes are the steepest pitches, and the rushing torrent does the rest. It is obvious that the gorge must quickly take on a water-worn look. Travelling up the valley past a monastery perched on a spur, past two cascades falling from hanging glaciers over the boundary cliffs of the overdeepened valley, we came almost to the foot of the great glacier, and started to climb above it by a very steep path. When overlooking the glacier foot we traversed for some miles, emerging at dusk into a meadow, opposite the point where the glacier poured into the main valley from a constellation of magnificent peaks. It had begun to rain, and clouds blotted out the view. A wall of séracs marked the flank of the glacier, and we looked on to a tumbled sea of ice rising steeply in front of us and passing out of sight below. The glacier then descended 1000 feet or more into the valley we had just left. We were behind it; and the river passed right under it. Above the glacier herdsmen tended their flocks in the wide wet pastures.

Next day we continued up the valley, past several herds. In the afternoon we camped beyond the highest tents at the foot of the Lochen La, and 6 or 8 miles above the great glacier. At this point we could ford the Po-Yigrong, which had its source in another large glacier less than 2 miles distant. The head of the valley is in fact clasped by a ring of ice. One glacier reaches the floor of the main valley, and flows lopsidedly down it for a mile; several smaller glaciers stuck on the cliffs above converge on it in a semicircle. Behind these rise a group of terrific sharp peaks. Thus I had reached the source of the Po-Yigrong; but apart from that I had only a rough idea of my whereabouts; nor would any existing map of this part of Tibet have helped me, though I

The gorge of the Yigrong: great snow range in background

regretted not having with me a copy of the reconnaissance survey we had made in 1924. That would have told me a good deal, as I was to discover two days later.

The ascent out of the valley to the Lochen La is steep, the last few hundred feet over bare rock; close to the pass a small detached glacier is fast dwindling to a mere snow bed. I climbed to a peak above the pass commanding a view all round, but a blizzard of snow blowing up from the other side rather spoilt things. A low stone wall had been built across the saddle to protect travellers caught as we were. Beyond the glaciated Po-Yigrong valley far away in the east I saw snow-covered mountains buried in yeasty clouds. The highest visible peak, perhaps 23,000 feet, was not more than 2 or 3 miles distant to the north-west. The view southwards and westwards from the pass was restricted. We descended by a series of abrupt steps into larger and larger glaciated valleys, first south then west, then south again, and finally west; at the head of each valley were snow peaks and glaciers.

When we resumed the descent on August 21 we quickly reached a valley which looked vaguely familiar, and turned upstream north-westwards. A horseman who accompanied us from camp turned down the valley bound for Shoga Dzong. This then was the valley Cawdor and I had come up from Drukla Gompa in 1924; we had crossed the Pasum Kye La at its head, and reached the Atsa Tso, on the Gyalam. The topography of the region now becomes clearer. The Pasum Kye La crosses the Po-Yigrong range just west of the source of the Po-Yigrong. I had already suggested that the stream which flows eastwards from the Atsa Tso is the source of the Po-Yigrong. This proves to be incorrect, though it is quite possible and even probable that this stream joins the Po-Yigrong lower down.[1] Nor is the Po-Yigrong range here the watershed between the Salween and Tsangpo systems. We did no more than cross our track of 1924, ascending westwards to a hanging valley. In pouring rain we camped above the tree line at about 15,000 feet.

On August 22 we crossed the Tse La over a rocky ridge; this pass and the Lochen La are both about 17,000 feet. From the top I observed snow peaks and glaciers to east and north-west, quite close. We descended into a fairly broad valley, occupied as usual by herds. Next day we reached a village—Nyemna—and shortly after the Gyalam at Laru, through which we had passed on our way from Atsa to Gyamda in 1924. I was now convinced from the snow peaks which formed the northern flank of the valley above Laru, that the Po-Yigrong range extended westwards, north of Gyamda; though this requires further confirmation. Hence the Gyalam must cross it on the way to Atsa as shown on our map of 1924. There are certainly snow peaks immediately west of the Laru–Gyamda road, as well as immediately to the south-west of Gyamda; and all these peaks may lie on the one great range. Gyamda had not altered for the better in eleven years. The one shop it then boasted—kept by a Chinaman, had closed down; but a new bridge has been built over the river. I could buy nothing in Gyamda itself; but at this season big Lhasa-bound caravans from eastern Tibet pass through almost daily, and we bought

[1] The tributary which joins the Po-Yigrong at Nyöme from the west may be this stream; or possibly it is the large stream from the north-west which enters the plain at Temo Chamna.

Confluence of the Gyamda chu with the Tsangpo at Tsela Dzong

some brick tea. We now enjoyed several days of fine sunny weather, though I was sorry it had not come while we were on the passes.

There are two direct routes from Gyamda to Takpo and Tsari followed by traders and pilgrims, one *via* the Sho La, the other a little farther west *via* the Ashang Kang La. I chose the latter. On August 28 I started westwards again up the valley of the Gyamda chu, and when a few miles out on the Lhasa road, observed a snow peak on the range to the south of us. The valley however is deep, and I could see nothing of any snow peaks to the north, though the fact that we crossed two big tributaries flowing from that direction indicated the presence of a high range. The granite so conspicuous round Gyamda was now replaced by metamorphics, perhaps due to contact between the igneous rocks of the Po-Yigrong range and the sedimentary rocks of the Lhasa region.

For two days we followed the road to Lhasa through a broad well-wooded valley, the stony river terraces, which are very conspicuous, affording little opportunity either for grazing or cultivation. On the third day we turned abruptly south up a wide valley to a small village called De. Continuing a few miles above the village, we camped with the herds on a grassy plain.

A long march up the valley, almost due south, on the last day of August brought us at dusk to the highest camp. There were snow peaks and glaciers both to north and south, but they are not above 20,000 feet altitude. On September 1 we crossed the Ashang Kang La, a high bare saddle covered with loose rocks of arkose. Just below the pass on the north side the valley divides; and the more westerly branch crosses the range by another pass, the Gechi La, which leads into the Chögorche valley. I had intended to follow this route in order to visit the "rainbow" lake above Chögorche, mentioned by A. K.; but hearing that the ministers of Tibet were in summer residence at Chögorche, I altered my course.

From the Ashang Kang La I looked down a long ice-worn valley enclosed by high sierra-like ridges; there was a small lake at its head. The scenery was grim. We camped again with the herds, and next day before continuing our journey towards the Tsangpo, visited a sacred lake called Gaylam Tso, in a hanging valley. This is a place of pilgrimage, and some of the Lhasa ministers had visited it from Chögorche only the previous month, and set up a shrine flanked by tall poles at one end of the lake. It is an ordinary glacier lake. A long march down the alpine valley nearly due east, brought us into a larger glaciated valley, with signs of cultivation, and again we turned south. It was dark when we reached the wretched village of Nye, where I rested a day. There were numerous Tibetan hill partridges here (*Perdix hodgsoniae*), a bird common in the scrub-covered alpine valleys of south-eastern Tibet.

On September 4 we marched south and south-west down the narrow wooded valley between high granite cliffs. The gradient was irregular, rapids alternating with quiet lake-like expanses, where drowned trees were conspicuous. The path was overgrown and apparently not much used, but we had no climbing. Having covered about 15 miles in ten hours, we reached a small village, Sham, at dusk. There are houses on both sides of the river. Here the high scarped cliffs were definitely forested with Pine. A few hours' march next day brought us to the Tsangpo valley opposite Tromda, whence the Takpo road continues up a valley to Guru Namgye Dzong. The rock

had changed abruptly again from granite to metamorphic, and there were no trees, except in the villages; but the dryness was confined to the main valley and its immediate precincts. An almost forest climate prevails within 2 miles of the river on either side. Fifty miles downstream the outer plateau passes definitely into the river gorge region, forest growing actually by the river.[1] But just here the Tsangpo valley itself is still arid, owing to the fierce winds which scour it. Sand hills—they are hardly dunes, often only high sand slopes—occur frequently and support a characteristic flora. All crops are irrigated. The river winds its way through the hills almost as though it were crossing a flood plain; but the current is swift. A sudden furious squall assailed us with rain, lightning and wind of gale force. It passed on down the valley, and within an hour all was peaceful again. We crossed the river in a sort of wooden box, sculled by one man, and reached Tromda on the ninth day from Gyamda. Here I was compelled by sickness to rest two days. Hares abound in the thorn scrub which covers much of the flat sandy bank; and I saw big fish leaping in the muddy river.

On September 8 we set out again, travelling up a stream from the south, and passing the picturesque little monastery of Ganden Rapden sunk in a welter of unsavoury hovels, ended the short day's march at Guru Namgye Dzong, about 6 miles from the Tsangpo. The original *dzong* was superbly sited on a spur rising abruptly from the narrow valley. It is now in ruins, and the modern *dzong* stands by the stream. Paper is made here from the bark of a shrub said to come from farther west, though what shrub would grow on the dry plateau farther west and not here (even if no one took the least trouble to cultivate it) it is difficult to imagine. Guru Namgye Dzong, though a tiny place, has some status: it controls the Tsari valley, which has no *dzong* of its own.

Our next march was a longer one, up the dry, but not arid, valley to the last herdsmen's village of stone houses. There was no cultivation. The weather had turned cold, and it was bleak here at about 14,000 feet, with snow on the range ahead. On the way we passed the quaint little monastery of Boomda Semung. By taking this route we had to cross two passes in order to reach Sanga Chöling; but the Kongma La and the Cha La (previously crossed on July 1) are very close together and on the same range; we should have crossed them both in one day had I not turned down the Tsari valley in order to revisit Chösam. However there was an alternative route to Sanga Chöling, crossing only one pass, the Karpo Ra La: in other words a single-fold range separates the Char chu from the Tsangpo, and our having to cross the Bimbi La in order to reach the Tsangpo from Tsari does not vitiate the fact. The Bimbi La crosses a spur, not the main range; we were already over the northern fold range when we reached the Tsari valley after crossing the Cha La, in July.

The Kongma La, 17,520 feet, is an easy pass. It had previously been crossed by Bailey and Morshead in 1913. Very heavy rain greeted us on the other side, and it was a wet, cold, and tired party that reached Chösam at dusk. I did a day's botanizing here, and then crossed the Rip La over the Takpo

[1] See "A Sketch of the Botany and Geography of Tibet," *Journal of the Linnean Society*, September 1935.

Shiri range—part of the northern fold range just referred to. Here I was amongst glaciers and deeply ice-graved valleys again. At the village of Yüto—one occupied and two empty houses where pilgrims put up—we spent the night before crossing the rather formidable Takar La, about 17,000 feet and steep on both sides. Descending from the Takar La we reached the valley below the Cha La, where we had camped on June 30. There were more alpine flowers here now than in June, and the banks were blue with Gentians and *Cyananthus*. Next day we arrived back at Sanga Chöling. Only the southern fold range now separated me from my base at Chayul Dzong. The ordinary route is over the Le La, a three-days' journey. I decided to cross the unknown Mo La, taking four days.

Travelling westwards a short day's journey up the dry Char chu valley, we reached the small village of Bung. Here we crossed to the right bank, and turning up a well-wooded side valley, where we saw Harman's pheasants, we ascended glacier-worn rocks and high screes to the Mo La about 17,000 feet. The valley divides below, the other branch leading to the Dongyu La, an alternative pass to the Nye chu. On the screes we saw a number of Himalayan Snow-cock (*Tetragallus himalayensis*). These birds when frightened run up hill, calling shrilly, then suddenly rise and plane very fast down into the valley below. In summer at least they are not found below 15,000 feet, keeping to the apparently bare screes and jagged ridges. Right on the Mo La a sudden snow squall blinded us for a few minutes. The view to the north was restricted by the nearness of the northern fold range, but far away to the south-west the Assam Himalaya rose into view. In the foreground a snow bed nestled against a high rock peak, but I could see no glaciers. The slate rocks were highly contorted.

A long march down the narrowing valley brought us at nightfall to a large village with scores of narrow cultivated terraces on both banks of the river. Daylight—a bright sunny morning—showed Dikiling to be a prosperous-looking village situated in an arid valley at about 13,000 feet. We soon reached the Nye chu, a western tributary of the Loro chu. It is a muddy river with a rapid stream. The hot valley is extensively cultivated, with numerous small villages perched up on the gravel cliffs. Though the houses were poor looking, almost every village boasted a fine monastery or at least a *chorten*. The outstanding example is Shangtze Gompa. Above this point is the district of Nye, below that of Chayul. The Nye chu is a typical treeless plateau valley, with river terraces cut in the flanks, and miles of irrigation channels. We turned eastwards down the river, presently reaching Potung Yangze. The contrast between the wretched hovels which comprise the village, situated in a grove of hoary old poplars of great bulk, and the splendid monastery astride the sharp ridge which overlooks it, is extreme. A torrent comes tumbling down here; up it is the route to the aforementioned Dongyu La.

The valley of the Nye chu now changes its appearance, growing narrower and rapidly steeper as it turns abruptly south. Here it is cutting its way across the strike of the strata, and also across part of the southern fold range. The path became more difficult and the last march proved arduous. Towards evening, having descended many hundred feet, we reached the Loro chu, and shortly afterwards Chayul Dzong; the country was even barer and more

scorched than at the end of June, in spite of such summer rain as it had received. Evidently the drying effect of the wind had more than compensated for any rain. I had been absent just ninety days, and had covered roughly 800 miles mostly through unexplored country, and in regions which hitherto had been a closed book to the botanist. My botanical collection numbered about six hundred species, chiefly alpines.

Resting only a few days to pack my collection, I started back for India on September 27, retracing my steps to Karta. I had a little difficulty in getting transport, and it was October 3 before we were able to leave Cha, a small village above Karta. The weather was brilliant, the sky cloudless, but I was hardly prepared so early in the winter for the low temperatures we experienced. At three o'clock in the afternoon we crossed the Pen La, and met a bitter wind. We had to camp at nearly 16,000 feet, and though the wind died down in the night, the temperature inside my tent at dawn was 16° below freezing-point. However on the following day we crossed the Tulung La, and were over the Great Himalaya. From the Tulung La I observed a snow range to the north-west in the direction of Tsona Dzong. Immediately east of the pass is a ring of snow peaks, about 19,000 feet high, with squat glaciers which formerly descended far down the valley. Cold as it was there were pheasants calling from the screes at 15,000 feet. We reached Mago on the 5th, the herds were just leaving Chunak. I decided to return to Dirang Dzong by the so-called main road. After crossing the Chera La above Mago (whence Gori Chen, 21,450 feet, was visible) we continued up the Gorjo chu and next day crossed the easy Tse La, 15,550 feet. The Gorjo chu, which below the Chera La is a boisterous torrent, flows peacefully in a wide glaciated valley higher up. The southern slopes of the range are steep. Passing two small glacier lakes we soon reached a stream lined with rhododendron and deciduous shrubs. Camp was pitched on the fringe of the fir forest, at a regular halting stage. After a white frost which curled and stiffened the leaves of the rhododendrons, we climbed steadily to another pass, the Pang La, which brought us on to a ridge. At the southern end of the ridge was the Poshing La and a cruel descent for the yak, down a gigantic and disrupted stone stairway. A freezing mist made things more unpleasant. The steep descent continued until we were well into the forested Himalaya, when we camped on an open shoulder, commanding a magnificent panorama to the south and west. On October 11 we reached the first residential area since leaving Mago: a miserable monastery called Lagam. Continuing the descent towards the western branch of the Bhareli, we arrived at Tembang, a large Mönba village, after dark.

Another long march on the fifth day out from Mago brought us to Dirang Dzong. It seemed very hot down here after the cold of Tibet. From Dirang Dzong I retraced my steps over the Manda La and two lower passes to Shergaon. Travel throughout the pine-clad minor valleys of the Assam Himalaya was easy even in the middle of October, and the country was so dry it might have had no rain for weeks. Shergaon was warm by day but we had frost at night. I learnt that it was impossible to cross the Pankim La for two months, so I turned eastwards towards the Bhareli, reaching Rupa on the second day. Just above Rupa the stream breaks through a gorge of crystalline limestone (dolomite), where a distinct flora prevails. A beautiful

slipper orchid (*Cypripedium*) was in flower on the cliffs. *Cupressus torulosa*, a somewhat rare Himalayan conifer, not known east of Nepal until Dr. N. L. Bor, I.F.S., discovered it here a few years ago, was scattered about, and several other plants caught my attention. From Rupa I continued eastwards to the Koyutsum village of Jamiri, passing abruptly from the pine-oak forest of the inner valleys, to the Indo-Malayan rain forest of Assam, though there is no visible barrier. From Jamiri I was able to turn south again and crossing the last range at under 6000 feet we reached the Bhareli river on October 26. We were now almost on the plain. Two days later we crossed the mythical "inner line" into administered territory; and Tezpur was reached at the beginning of November after a journey lasting six months.

The principal geographical results of my journey and the conclusions to be drawn from them may be summarized as follows:

I. Between the Assam Himalaya and the Tsangpo are two lesser ranges of fold mountains, composed mainly of sedimentary rocks. These ranges can be traced from the 92nd to the 94th meridian, east of which they disappear. Both ranges are intermittently elevated above the snow line though the peaks probably nowhere exceed 20,000 feet. The many glaciers have long since disappeared. Takpa Shiri stands on the southernmost range; it is not on the main Himalayan range. The high peaks immediately east of the Trigu Tso observed in 1924 probably stand on the northern range.

II. These fold mountains are composed of slates, phyllites, schists, and limestone, with numerous quartz veins, and are highly contorted. Examples of this contortion are particularly well seen immediately north of the Rip La, north of the Mo La, and in the gorge of the Char chu below Sanga Chöling. On the sierra-like ranges the strata are often vertical and the sharp saw-edged spurs present one precipitous and one sloping face.

III. The Loro chu and the Char chu both flow along cracked anticlines, as is shown by the rocks dipping away from the rivers on both sides. The strike of the rocks is approximately east–west. These valleys are not glaciated, though the short tributary valleys from north and south are glaciated in their upper courses.

IV. North of the Tsangpo, between the same meridians, 91°–94°, is a single range separating the basin of the Tsangpo to the south from those of the Gyamda and Kyi rivers to the north. There are snow peaks and small glaciers on this range also, but it has been much more extensively glaciated in the past. It has little in common with the fold ranges to the south however, for it is composed mainly of igneous, not sedimentary, rocks; towards the summit of the range the rock is sometimes arkose, formed directly from the decomposition of igneous rock. Possibly, as suggested in an earlier paper,[1] it is a continuation of the range north of Gyantse, which may cross the Tsangpo in longitude 92° 30′. The general direction of this range, where it has been observed, is north-east–south-west, that is parallel to the main Himalayan range. East of Tsetang, four passes, the Kumba La, Gechi La, Ashang Kang La, and Sho La, connect the Tsangpo valley with the Gyalam (or China road) between Lhasa and Gyamda. These passes are used by traders between

[1] *Geogr. J.*, February 1926.

Takpo and the north and by pilgrims visiting Tsari. The Ashang Kang La was the only one explored in 1935. I crossed the Kumba La in 1925.

V. Broadly speaking the evidence of former glaciation in Tibet, south of the Salween river, decreases from east to west. There is ample evidence of glaciation on the transverse ranges which cross the plateau north of the Himalaya, at least as far west as the 90th meridian; but none whatever for the glaciation of the plateau itself, though it formerly enjoyed a moister climate.

VI. I was able to extend considerably the known areas of most intense glaciation in south-eastern Tibet, to north, south, and west. Thus the whole of Tsari has been glaciated: the mountains between Tsari and the Tsangpo, the range north of the Tsangpo referred to under IV above, and the upper Po-Yigrong basin. It is hardly an exaggeration to say that during the maximum advance of the ice the whole of south-eastern Tibet between the meridians of 90° and 100°, and the parallels of 28°–32°, was covered by an ice sheet, so large and numerous were the glaciers. This represents an area of about 150,000 square miles, and it was by far the largest (more or less) continuous ice sheet north of the Himalaya.

VII. One inevitable result of the retreat of the glaciers has been a diminution in the volume of the rivers which they feed. This is well seen in the headwaters of rivers like the Subansiri, particularly the Loro chu. The vast accumulation of gravel in the valley below Karta was laid down by a much larger stream than the present one, as the size of the boulders moved also testifies.

VIII. The following five passes south of the Tsangpo were crossed and explored for the first time. Over the southern fold range, the Drichung La and Mo La. Between Sanga Chöling and Tsari, the Rip La. Between Tsari and the Tsangpo, the Bimbi La and Lang La.

IX. Beyond Migyitun and the Tsari river the sacred lake Tsoga, and the snow peaks and glaciers overhanging it, were discovered. These peaks are probably on the main Himalayan range.

X. North of the Tsangpo, from west of the 94th meridian to east of the 95th stretches a great range of snow mountains comparable in height with those at the eastern end of the Assam Himalaya. Its distance from the Tsangpo varies from less than 25 miles in the neighbourhood of the 95th meridian to over 50 miles farther west. This range, in the portion explored between Gyamda and Tongkyuk, trends approximately east–west, and converges on the Assam Himalaya towards Namcha Barwa. There is no record of its having been observed from the north; but in 1924 Lord Cawdor and I obtained an extensive view of it from Tsela Dzong at a distance of about 50 miles. I propose to call it the Po-Yigrong range, since the part explored lies in the Po country.

XI. This range is composed mainly of igneous rocks. There is no evidence however, other than its igneous composition, that it is an eastward extension of the range I crossed between the Gyamda river and the Tsangpo. It seems more likely that its westward extension lies north of Gyamda, where it forms perhaps the northern watershed of the Gyamda river system.

XII. Its glaciers give origin to the following rivers: Yigrong and Tongkyuk rivers entirely; Gyamda river (eastern branch) entirely or mainly; tributaries

of the Gyamda river, *viz*. Drukla chu, Pasum chu, and a few smaller left-bank tributaries.

XIII. The main part of the Po-Yigrong range lies south of the Po-Yigrong, and the highest peaks stand between that river and the Pasum Tso drainage. But the snow peaks north of the Po-Yigrong might also be on the same range, if the range has a double crest line. The Po-Yigrong appears to have cut its valley athwart the range.

XIV. The following passes in order from east to west are on the main range: Sobhe La, Ba La, Lochen La, Tse La, Pasum Kye La. The Sobhe La, Lochen La, and Tse La were crossed for the first time, and the Ba La roughly located. Lord Cawdor and I discovered and crossed the Pasum Kye La in 1924. The Nambu La, crossed in 1924 and again in January 1925, is not in the main range.

XV. The high peaks occur in groups. One group stands opposite and south of Ragoonka; another group which gives origin to a large glacier blocking the Po-Yigrong valley is near Nyotö; a third, at the extreme head of the valley. The height of no peak is known. From the size of the glaciers and the levels to which they descend it is safe to say that the highest peaks exceed 23,000 feet. All the glaciers seen are, and have long been, retreating. Nevertheless they rank with the largest known north of the Tsangpo.

XVI. I followed the gorge of the Po Yigrong westwards for nearly 100 miles, discovered the large villages of Temo Chamna, Tage, Ragoonka, Nyöme, and Nyotö, and found the source of the river in a group of glaciers just south of Atsa. The only *longitudinal* glaciers observed are at the source of the Po-Yigrong. I counted over forty transverse glaciers descending to the Po-Yigrong between the Sobhe La and the Lochen La. In 1925 I suggested that the stream which flows eastward from the Atsa Tso might prove to be the source of the Po-Yigrong. This is now known to be incorrect, though it is quite possible that the Atsa Tso flows into the Po-Yigrong system lower down.

XVII. The gorge of the Po-Yigrong is comparable with that of the Tsangpo itself in depth, though not in length.

XVIII. There is only one route out of the Po-Yigrong gorge northwards, namely that up the Alado [1] chu from Nyo. This route crosses the Alado La, and two other passes and connects with the Gyalam east of Atsa at Alado.

XIX. The east and west continuations of the range are unexplored, but eastwards it certainly extends through Pome. Gyala Peri and Markandro, the latter peak discovered in 1924, appear to be directly connected neither with this range nor with the Assam Himalaya. Gyala Peri is almost due north of Namcha Barwa, at a distance of 16 miles, so that it can hardly stand on the main Himalayan range which is here particularly narrow. There is more evidence to connect these peaks with the "Ladakh" range than with the Himalaya; they may stand on the eastward extension of the range already referred to as separating the Tsangpo from the Gyamda and Kyi rivers, which in turn may continue the "Ladakh" range. Namcha Barwa is 45 miles due north of the Dihang, and 120 miles from the foot of the Himalaya in Assam. As the fold range must have some extension northwards from its

[1] Alando as pronounced to me; I have not altered the present spelling.

crest line, the width of the Himalaya, to include both Namcha Barwa and Gyala Peri, would be about 200 miles. Even where it is broadest, the Himalayan range does not exceed 125 miles from north to south.

XX. The Po-Yigrong range is not, at least in the region explored, the Tsangpo–Salween watershed, which lies farther north. This region appears to be a region of maximum elevation, both for the Assam Himalaya (Namcha Barwa, Sanglung) and for the ranges north of it—the Gyala Peri and Po-Yigrong ranges.

XXI. Crossing the plateau of Tibet are great ranges of mountains separated by wide shallow troughs. In eastern and south-eastern Tibet more ranges emerge than entered it in the west, they are closer together and less parallel than the central Tibetan ranges. It appears that some of the original wide ranges have been split by longitudinal glaciers, and the work of dissection completed by rivers. But some of the eastern Tibetan ranges may originate there. Before the geography of Tibet can be understood the difficult task remains to rebuild the original ranges as they were upraised, combining the parts correctly. The Po-Yigrong range bears much the same relation to the eastern Himalaya that the "Ladakh" range (in long. 76° E.) bears to the western Himalaya.

XXII. The Po-Yigrong range defines the boundary between the forested Po country to the south and the dry grazing plateau country to the north. It fulfils farther east the function of the Assam Himalaya in the west, that of a rain screen.

XXIII. The Gyalam nowhere touches the main course of the Po-Yigrong, but is separated from it by the great snow range which I crossed. In the most recent map of this part of Tibet published by the Survey of India, corrected to 1929 (sheet 82 1/M) two streams are shown between the meridians of 94° and 95°, meeting at Alado; the Sya chu from the east, the Nok chu from the west. These are shown as the sources of the Po-Yigrong. They can be however no more than the sources of a tributary, since the main stream flows from the west, some distance south of Alado. From Nyöme three passes have to be crossed before Alado is reached. This might mean either that the two streams first mentioned do not flow to the Po-Yigrong, or that the Alado chu flows in a deep and narrow gorge, as in fact I saw it doing. The big stream which flows past Pungkar and Drukla Gompa is the one I crossed between the Lochen La and the Tse La; it rises amongst snow peaks round the Pasum Kye La, which separate it from the Atsa Tso. My journey definitely links up these peaks with Namla Karpo, the high peak identified in 1924, and those round the Sobhe La north of Tongkyuk, all of which stand on the one range—the range Cawdor and I saw north of us in 1924. The snow peaks near the Ashang Kang La probably lie on another range.

XXIV. There remains the possibility that the Po-Yigrong range is the eastward extension of the Ninchinthangla range, which Burrard suggests, reasonably, is continued eastwards. But in longitude 93° E. that range is 120 miles north of the Tsangpo whereas the Po-Yigrong range is nowhere more than 50 miles distant. The Littledales crossed the Ninchinthangla range north of Lhasa; but Nain Singh, who traced it for 150 miles, found that it trended north-eastwards, forming the watershed between the Tsangpo and the

Tibet lake-basin. Thus in longitude 94° E. it is a long way north of where I crossed the Po-Yigrong range. The two cannot be identified.

XXV. The botanical results are of exceptional interest and throw considerable light on the origin and distribution of the Tibetan flora. I was able to confirm the separation of the flora into two zones, a "dry" flora and a "wet" or forest flora corresponding to the two main divisions of the country, namely the main plateau and the dissected plateau or river gorge region.[1] The "dry" flora is further divisible into a plateau flora proper (either "cold dry," or "warm dry") and an alpine flora on the transverse ranges; these botanical divisions corresponding with the physical features of the country. The "wet" flora is likewise divisible into forest filling the gorges themselves, and an alpine flora on the enclosing ranges. Finally the unity of the Tibetan flora has been again demonstrated, and its similarity to that of western China and the Himalaya established. The botanical results are however fully dealt with elsewhere.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: My Lords, Ladies and Gentlemen,—The older I grow the quicker time seems to go. It seems to me only the other day that we welcomed Mr. Kingdon Ward here on his return from his previous journey of 1934, after which he read us a paper entitled "The Himalaya East of the Tsangpo." In thanking him for that paper you joined me in expressing the hope that it would not be long before he set out again. He has now returned after another fine trip, having been away a year during which he has covered a great deal of ground, this time not in the Himalayas but beyond the mountainous country north of the Tsangpo. Those of you who were present at his lecture of November 1934 will recall the beautiful photographs that he showed us, and I am sure are looking forward very keenly to what he is going to present to us this evening.

It is quite superfluous for me to take up time with any introduction of Mr. Kingdon Ward. As you know, he is a Gold Medallist of the Society, and is a familiar figure on our platform. I ask him now to read his paper.

Mr. Kingdon Ward then read the paper printed above, and a discussion followed.

The PRESIDENT: This evening Lord Aberconway has honoured us by his presence. Those who have been reading their newspapers regularly during the past few days will perhaps suppose that he has come to tell us something about the trials of the *Queen Mary*, but it is not in that connection that he is with us. He has come as President of the Royal Horticultural Society, and it is in that capacity that I ask him to come on to the platform and make some observations on the most interesting paper to which we have listened.

Lord ABERCONWAY: Mr. President, Mr. Kingdon Ward, My Lords, Ladies and Gentlemen,—I feel diffident in coming on to this platform, for I have not the honour to be a Fellow of this learned Society, and I am in no way a learned person. My only qualification is that I am a great admirer of Mr. Kingdon Ward and all his works.

I have been privileged to be the recipient of lavish portions of the seeds which he has collected in distant lands; collected not, as he would modestly lead you to believe, by strolling through flowery meads in pleasant weather with the sun shining, but, as I know from him, very often collected under the most horrible conditions, when wet days succeeded wet days, with nothing to live in but a

[1] "A Sketch of the Botany and Geography of Tibet," *Journal of the Linnean Society*, September 1935.

hut whose roof was chiefly holes and where it was impossible to get dry. We who take an interest in plants are most grateful to Mr. Kingdon Ward for all that he has done for us.

I have received the products of many botanical expeditions, but I do not think that any botanical explorer has in one year given us a richer harvest for our gardens than did Mr. Kingdon Ward when he returned from the expedition of 1924, when he first explored the mysteries of the Tsangpo gorge. I believe too that that expedition of his was almost as prolific of new facts for geography as it was prolific of new plants for our gardens. There he found his wonderful *Meconopsis betonicifolia* or "*M. Baileyi*"; there he got countless primulas and countless dwarf rhododendrons. Each year that he goes afield he finds further treasures for our gardens.

There is always one difficulty in connection with plants from Tibet. They, as a rule, like a wet summer and a dry winter. They grow in winter in conditions of frost and snow, where they are frozen, where no rot can attack their roots. The woody plants, the shrubs and rhododendrons, do quite well in our climate if they have a certain amount of water during a very dry summer, because they are not plants that are likely to rot in our mild wet winters. When however you come to the Meconopsis tribe, to the Primula tribe, and the Gentian tribe, you find both that our summer is very dry for them—they suffer unduly even if they are plentifully watered in summer—while our winter is too wet for them and they are apt to rot off at the root.

That lovely yellow primula which Mr. Kingdon Ward showed on the screen but did not name to us, the germs of which I hope are contained in one of his packets of seeds—I regret to see him shake his head, and I fear he left the flower and returned by another route—is the kind of primula which is so lovely on a slide but by the look of it I think, even if he had collected it, would have been difficult to keep in a wet winter. It would have had to live unhappily under a pane of glass, and even then would probably not have survived.

But of all explorers I envy an explorer like Mr. Kingdon Ward, the results of whose explorations we can see every day now in some gardens, and I hope in the future we shall see in even more gardens. We see gardens enriched by the blue of his Meconopsis and gentians, the yellow of his primulas and the scarlet and purple of his rhododendrons, and we shall all be able to enjoy just in one small corner of our gardens one little peep into that glorious country covered with entrancing vegetation of which Mr. Kingdon Ward has given us to-night so excellent an account and representation.

The PRESIDENT: I now ask Mr. Ramsbottom to come on to the platform, if he will be so good. He is Keeper of Botany in the Natural History Museum, South Kensington, and must have interesting comment to make on our lecturer's collections.

Mr. J. RAMSBOTTOM: As you, sir, said, it seems but a very short time since Mr. Kingdon Ward gave his last lecture here. On that occasion I was privileged to say certain things about him, and I am afraid that what I say now may be something on the same lines.

When Kingdon Ward left England last he was rather hoping he would be granted permission to go into Tibet. He went for a short trip to the head-hunting country and then, having a chance to get over into Tibet, he went there. I had a wildly enthusiastic letter from him telling me that he had done it, and you have seen from the wonderful photographs he has shown that he really did do it.

Lord Aberconway has just said what we all know—although not so well as Lord Aberconway does—that horticulture in this country has benefited from the seeds which Mr. Kingdon Ward has brought back from his expeditions.

Now, though fully appreciative of this, it is the other part of Kingdon Ward's story about which I have to speak. When he began his lecture he said he went into Tibet to see what plants were there, how they got there, and how to get them out. There are two ways of getting them out. There is the one in which he sees a plant and goes back and gets the seeds—unless he goes by another route. That is the aspect which appeals to most here and an aspect which you know of.

The other aspect is that on every journey Kingdon Ward has collected plants which he has pressed and which have gone to some of the herbaria in this country. Following his last three or four journeys, the plants he has dried have come to the Department of Botany of the British Museum. Those dried plants are, in their way, just as beautiful as the photographs he has shown. One of the things that always surprises me about Kingdon Ward's travels is the magnificence of his photographs. I cannot think how he can obtain such wonderful photographs under such bad conditions as generally prevail. And moreover it also surprises me that he can bring back from his expeditions such wonderfully preserved plants. Dried plants will rot very quickly if they become damp: they are also very liable to damage by insects. If any here are interested in the collections I shall be very pleased to show them at the Natural History Museum. They are extremely beautiful plants, though of course not so beautiful as the plant you would grow in a garden—even a herbarium botanist is still a botanist and prefers to see a plant growing. Nevertheless if you are interested in dried specimens, Kingdon Ward's plants are exceedingly well preserved, no matter what your criterion is. When you consider his climbing of ladders in precipitous places, treading on snakes, and so on with collections of plants, you will wonder, as I always do, how he manages to bring the collections home.

Then Kingdon Ward said he went because he wanted to know what plants were there. In spite of all that has been said and written on the distribution of British plants we do not yet really know our own British flora completely, much less do we know the flora of places such as Tibet, some parts of which botanists have never trodden. I do not know whether I am right, but I think that Kingdon Ward is the first traveller to have visited certain parts of Tibet.

The question of getting a knowledge of the flora of Tibet is related to the problem of working out the relation of the Tibetan flora across to the Chinese flora and down to the Siamese flora.

Well, when one starts talking of Kingdon Ward one is apt to go on rather longer than one ought, but if I may add something to show the appreciation that botanists as botanists have of the work on geographical botany that Kingdon Ward has accomplished, I should like to say that the Linnean Society of London has appointed Mr. Kingdon Ward to give the Hooker lecture which is delivered every five years. He will give that lecture on April 23.

The PRESIDENT: I regret that, so far as I know, there is no one present who can speak on the geographical aspect and achievement of Mr. Kingdon Ward's journey. You will have noticed, as I did, that he said nothing as to his own arrangements for his daily bread—what he carried, whether he lived as a Tibetan, and, if not, how he lived. Before I sum up I would like him, if he will, to enlighten us a little on that subject.

Mr. F. KINGDON WARD: The essence of travelling rapidly in Asia is undoubtedly to travel light, though I do not profess to compete with Mlle. Maillart and Mr. Peter Fleming, who are able to cross Asia with two men, a boy and a donkey. I was however travelling pretty light.

I had when I left India twenty-four loads, a load being never more than about 50 lb. These included two boxes of stores, a couple of tents, my bedding

and that of two permanent servants with me, and of course a vast quantity of drying paper for plants. After travelling for about a month and having reached a convenient base in Tibet I dumped half my loads, put them in a sort of local cloak room as guarantee that I was returning there, and set out with twelve loads on a journey which I thought would keep me absent for about a month. I was actually absent for ninety days. Of those twelve loads two or three were botanical drying paper; I had also my bedding and that of my servants, tents, and a few cooking pots and stores. For the most part, my servants and I lived on the country. It is always possible to get butter and milk in Tibet, and the older I get the more easy I find it to live on milk. In fact, in my fiftieth year I lived chiefly on milk just as I did in my first year.

We did not get very much meat. At the higher altitudes the people do not keep chickens, and there is no other domestic bird which lays edible eggs. Yak are very common in Tibet especially at high altitudes, but they are too valuable to be killed for food. Occasionally a yak dies, and then meat is available.

On the whole, I think if one is sufficiently interested in one's work one does not bother much about meals. When alone one is apt to put such things into the background and, in any case, to hurry over them. It must be remembered that I had none but local interests. I was completely cut off from news of Europe; I had no letters from my family, and nothing to read except 'The History of Tom Jones' and Shakespeare. One cannot always be reading Shakespeare and I read 'Tom Jones' twice. Meals were not very interesting. I just hurried through them and then settled down to do my botanical work.

When you have no trained collectors with you and are travelling almost continuously it is not possible to train people to collect, so you have to do all your own, of course perpetually changing the drying paper and writing the field notes on specimens. That takes up a great deal of time. What with making arrangements for getting transport, writing up my field notes, collecting and drying specimens, one or two hours for meals and a few hours' sleep, my days and nights were, on the whole, pretty full.

The PRESIDENT: I am sure you all agree that the lecturer's little appendix has been very interesting and enlightening. I remember saying two years ago, when he was last with us, that although he undertook his expeditions primarily for botanical purposes, he had a keen eye for geography and never came back without some useful geographical achievement. As you will have realized, his last expedition was by no means an exception. It is gratifying to know that he has been able to locate and follow along a range which so far as I know, and I think so far as anybody knows, has not been seen previously by any European. We congratulate him heartily on that.

I know nothing of botany, but from other aspects of natural history I do know how trying it is and what intense labour and enthusiasm is needed to keep one up to attending to one's specimens after a long day's march; and not only that, but to the examination of them for days afterwards in order to see that nothing is going wrong. As you heard from Lord Aberconway and Mr. Ramsbottom, Kingdon Ward has excelled himself in that direction on this last expedition, with wonderful success.

I realize from the way in which he has held his audience throughout the evening and delighted them with those nice touches of humour which crop up every now and then, how greatly you have all enjoyed his lecture, and I ask you to thank him enthusiastically. I am sure we have not heard the last of him as an explorer, and we cordially wish him health and all else that is needed to enable him to pursue his most valuable voyages of discovery.

THE QUETTA EARTHQUAKE: *A paper read at the Evening Meeting of the Society on 8 June 1936, by*

C. P. SKRINE

AT the time of the earthquake of 31 May 1935 I held the appointment of Political Agent, Kalat and Chagai, in the Baluchistan Administration. My summer headquarters were at Mastung, a busy little township which has for centuries housed the Hindu traders who minister to the economic needs of the otherwise exclusively Muhammadan population. The Mastung *niabat* boasts the richest lands in all the province of Sarawan and its wheat is as renowned for its fine-milling qualities as its fruits and vegetables are for their size and flavour. It is ruled over by a *mustaufi* or district officer of the Khan of Kalat, whose wide but thinly populated territories comprise about three-quarters of British (as opposed to Iranian) Baluchistan. Its broad, flat-bottomed valley, some 5600 feet above the sea, adjoins the bleak uplands of Quetta 32 miles to the north, from which it is separated by a rocky chain culminating in the towering crags of Chiltan (10,850 feet). From the *lak* or pass by which the Quetta–Kalat road crosses the ridge the view southwards is impressive; in the middle distance the apricot orchards and mulberry groves of the Mastung group of villages lie like cloud-shadows upon the plain, and in the far south you can see on clear days the blue Harboi hills which screen the secluded uplands of Kalat, ancient home of the Ahmadzai Khans of the Brahui Confederacy.

On that fateful Friday night I had motored into Quetta to dine with a friend and see a film. The Baluchistan capital was at the height of its spring season. A week of official and private gaieties centring on the King's Birthday celebrations was about to begin. Four or five hundred British civil and military officers and their women-folk were next afternoon to meet a similar number of prominent local Indians at the annual garden party given by the Agent to the Governor-General and Chief Commissioner, Sir Norman Cater, at the Residency, famous for its lawns and the beauty of its rose gardens. The King's Birthday was to be celebrated on the Monday with a march-past befitting the second greatest military station in the British Empire; several open-air dances, including one for four hundred guests at the Residency, were coming off during the next few days; polo, tennis, cricket, aquatic sports, and other activities were in full swing. The weather was of the perfection which dwellers in the highlands of Baluchistan take as a matter of course in early summer and autumn; the winter snows and spring rains had been exceptionally copious, grazing was plentiful, and a bumper wheat crop was about to be harvested. Trade was improving and the influx of summer visitors from Sind and the Punjab greater than ever. Altogether, prospects in town and country were bright, and the summer season which had opened auspiciously with the Jubilee Celebrations in early May bade fair to be the happiest and most prosperous that Baluchistan had enjoyed for years.

At about half-past twelve I returned alone to Mastung, a full hour's run over hilly country in the dark. The Residency there was a long, roomy bungalow embellished by two squat machicolated towers of (apparently)

solid masonry, standing on a flat-topped mound above a most delectable and productive garden. Some 300 yards to the west stood the somewhat smaller house of my Assistant with its garden round it. I was the only European in Mastung that night, my Assistant and his wife having, fortunately for them, left for the week-end that very afternoon. My wife, no less luckily, was spending the summer in Kashmir. I remember going to bed, dog-tired, at about a quarter to two. In previous years I had been in the habit of sleeping out of doors long before the end of May; but the weather was exceptionally cool and I was still using a large, high-ceilinged bedroom on the eastern side of the house. The next thing I knew was that I was out of bed in my pyjamas and bare feet, groping about in pitch darkness with one idea in my head, "Get under a doorway." The air was full of acrid dust and I could scarcely breathe. I cannot say for certain that I heard any sound of earthquake or felt the ground move, but I have a vivid recollection of a faint distant clamour of human voices from the direction of the town. This ceased abruptly and was followed by silence as of the tomb. My bed had been within easy reach of a double doorway leading from the large, lofty bedroom into an empty, low-roofed sun-room. I had already nearly reached the double doorway when I awoke, and had thus, as it turned out, literally sleepwalked into safety, for my bed was already under the massive debris of the ceiling and main roof of the bungalow, while the sun-room (originally a veranda which had been built in) remained standing. This prompt action of the subconscious mind was the more remarkable in that I had had no previous earthquake experience whatever.[1] In mortal fear I groped my way over broken glass and fallen wardrobes to the outer door and tried to open it, but it had jammed. The open windows were protected with strong wire gauze, and I had for a moment the sense of being trapped and at the mercy of any further shocks which might occur. Somehow I managed to break a pane of glass in the door without cutting myself, and putting my head through shouted for help. To my relief, a Gurkha sentry of the guard came up. He seized my hands and pulled me through, and I stood leaning on him for a few moments, completely unnerved. Soon my servants came in the darkness from their quarters with a lantern. Their small and solidly built houses had only partially collapsed and no one had been seriously hurt. They found a blanket and a pair of native shoes for me, and when the dust had cleared we crept round the house at a safe distance and saw in the starlight what had happened. The place was a ruin. Nearly

[1] Another possible explanation of my curious experiences may be that I woke up and made for safety when my bed began to shake, but the noise and mental shock caused loss of memory of the few seconds immediately succeeding them. Cases of amnesia in such circumstances are not unknown. Similarly, the deathly silence which so impressed me may have been due to the dulling of my senses by intense excitement. Professor D. B. Langford, in his account of his experiences on the Manazuru peninsula in the Yokohama–Tokyo earthquake of 1923 (*Bull. Seismol. Soc. America*, vol. XIII, p. 135), describes how he and a companion watched a 300-foot cliff above them collapse without hearing a sound. "The apparent silence of the crumbling cliff," he says, "has struck me several times since. It is possible that the intense excitement dulled our senses." Mr. H. Weightman, I.C.S., who had an even narrower escape than mine when his bungalow collapsed at Quetta, told me that the silence immediately after the shock was so intense as to give him the impression that everybody in the world except himself was dead.

all of the roof and some of the inner walls had collapsed; the two squat towers mentioned above had crashed, the east one on top of my private office and part of the drawing-room, and the west one on my wife's bedroom. If she had been in it at the time she could not possibly have escaped being buried in a few seconds 8 feet deep in broken masonry and twisted girders. Likewise, if the east tower had fallen more to the north, or the west tower more to the east, the doorway under which I took refuge must have been crushed as well as the bedroom, and I should almost certainly have perished. All the interior of the house was a chaos; the rooms were nothing but heaps of bricks mixed with beams splintered to matchwood and heavy iron girders lying about like spillikins. Even so, the ruin was not so complete as that of my Assistant's bungalow, which I saw later in the morning. That had been simply flattened out by the roof settling down over the crushed walls like an extinguisher. No human being sleeping in it could possibly have escaped; the watchman told me that the place was flat within a few seconds of the shock. Three of Captain Bazalgette's four dogs were however dug out alive, two the same day and the third, a beloved dachshund, no less than five days later.

Clad in pyjamas, a battered Burberry, and my bedroom slippers I made my way through the garden to the clerks' lines and was much relieved to find them all safe, collected in panic-stricken groups outside their ruined houses. One had lost his wife, another a child, a third his servant, no more. The hill on which the clerks' quarters, club, library, etc., were built seemed to have been less badly shaken than the rest of the town, of which scarcely one brick remained above another. Forming ourselves into parties for rescue work, we who had escaped so lightly pushed on into the town. The first thing I noticed was the silence. Why were there no groups of frightened inhabitants standing about in knots, why no shouting and excitement? Never shall I forget the horror with which I realized that there was scarcely anybody left alive to shout—the majority of the people were buried under the ruins, and the few survivors were either too dazed to make a sound or were trying to pull their folk out of the debris. The work of rescue was made no easier by the minor earthquakes which followed each other in quick succession throughout the rest of the night. Every now and again, as we frantically pulled and scraped at some pitiful bundle of clothes and tortured flesh pinned down by wall and rafter, the terrible deep thunder of earthquake would be heard again and the ground would shake and sway, sending us scuttling out into the open like bolting rabbits.

By dawn it was clear that the whole town was in ruins with 60 or 70 per cent. casualties, mostly dead. The only doctor, a Sub-assistant Surgeon, was doing what he could for the scores of injured who were being brought to him, but his instruments and medicines were buried in the ruins of his dispensary and he was desperate. The telegraph line was broken, so there was obviously nothing for it but to try to get into Quetta for help. It did not occur to any of us that the state of Quetta could be anything like that of Mastung and that help would not be immediately forthcoming. Accordingly I returned to the Residency, salvaged a pair of trousers and a shirt from the remains of my dressing-room, and examined the garage. Much to my relief, the office lorry and two big touring cars were not seriously damaged, though battered

1. Hindu quarter at Mastung

2. The Residency, Mastung: showing in the middle the author's bedroom

W. D. W.

3. Twisted rail near Mastung

W. D. W.

4. Bridge on the Quetta–Mastung road

W. D. W.

W. D. W.

by falling bricks. But the building had partially collapsed and the doors were jammed, and the only car we could get out and start was the little Austin Seven tourer, from which we had to rip its tattered hood. In this at a quarter-past seven my head mechanic, Haji Gul Muhammad, my bearer, Ahmad Din, another driver and I sallied forth with pick and shovel. Before starting I "shot" the ruined Residency and other scenes with my cine-camera, which to my great joy I had discovered undamaged in the porch, with nearly 50 feet of unexposed film in it. These pictures, and others I took on the road and at Quetta the same day, came out very well and form a unique record of the morning after the earthquake.

It took us an hour and a half to clear with pick and shovel a narrow track for the car out of Mastung and its environs, the walls and buildings having in many places fallen across the road. Everywhere was desolation. The only living beings visible were a few apathetic men and women wandering about among the ruins of their homes, and a few injured lying under the trees with no one to look after them. Five miles down the road we nearly upset into a fissure in the road; for about a mile the earth was cracked in many places and though none of the cracks were deep we had to shovel in quantities of stones and earth before we could get the car across. Then came a bridge which was badly knocked about and obviously very unsafe; we had to dive into the ravine it crossed, dash the sand at the bottom, and crawl up the bank on the further side, making a road for the car as we went. Then came the pass, where the roadway, to our surprise, had not fallen down the hillside, though we had to hug the inner ditch to avoid the cracked outer edge. The precipices of Chiltan towering 4000 feet above us were still raining down boulders, the dust from the rockfalls flying up in great clouds which made the whole mountain smoke like a volcano. With painful anxiety we reached the top of the pass, whence Quetta is visible 15 miles away in clear weather. What were we going to see? Our worst fears were confirmed when we looked across the void and saw a huge, sinister, pale brown cloud brooding over the distant town. Never shall I forget the shape of that cloud. The morning breeze and the smoke of fires had caught it up into a peak at one end, giving the impression of an awful misshapen hand stretched over the city. We pressed on as fast as the little car would carry us along the last 16 miles into Quetta. Any remaining hopes we might have had were dashed to the ground by the sight of the first bungalow we passed 4 miles out of Quetta on the Sariab road. It was nothing but a crumpled roof lying on top of a heap of bricks and broken timber, and all the other villas we passed, residences of retired officials for the most part, were the same. Nowhere was any sign of life to be seen. Then came a most welcome sight. The railway line to India runs parallel to the Sariab road at a distance of about half a mile. There, scudding southwards, was a rail-motor trolley! There was somebody alive in Quetta, then, after all. I heard afterwards that it was the Divisional Superintendent, Mr. Bean, proceeding most hazardously down the line to see whether it had been destroyed in the Bolan Pass, as might well have been the case. He got as far as Kolepur at the head of the Bolan, and his telegrams to Simla and Lahore were, I believe, the first intimation the Government of India received of the disaster. The slightness of the damage done to the main

line was one of the most providential as well as remarkable features of the earthquake.

We made our way to the suburb in which lived Gul Muhammad's brothers. Gul shouted in Brahui to a neighbour he saw in the road. I could not understand the reply, but there was no doubt as to its nature; Gul burst into tears and I had to seize the wheel to prevent the car running into a ditch. The houses where the two families lived had been completely flattened out. Not one brick stood above another. The three men got out and went clambering over the ruins while I sat under a tree, overwhelmed with the pity and horror of it all. Under the same tree were two women and a man, apparently uninjured, but dazed and beaten. They were the only survivors of a family of eighteen, in which all the children had been killed as well as some of the adults. The man with a pathetic attempt at hospitality brought a turned-up packing case for me to sit on. I felt I ought to follow Gul over the mounds and help him with his relatives, but I simply could not face the spectacle of their sorrow. When the three men came back, they told me that Azim and Amir Bakhsh and their wives had escaped with injuries, but the former had lost two of his three little boys including Muhammad Nur, the apple of his eye, and Amir Bakhsh all his three daughters. Promising medical assistance and food as soon as possible I got into the car again and drove through scenes of awful desolation to the Civil Lines.

Here, in shady Gymkhana and Lytton Roads, hardly a house could be seen standing. Through the trees, in the midst of flower gardens and orchards, bungalow after bungalow of my colleagues of the Civil Administration lay in ruins. My relief was unbounded when I came to the big two-storeyed Residency and found it standing, though badly knocked about, and the Agent to the Governor-General, Sir Norman Cater, standing with two or three friends on the lawn, calm and collected though grave, and immaculately turned out as ever. He had escaped from the house a few seconds before the heavy porch and double-storeyed veranda had crashed in ruin, killing three of the Gurkha guard. Tents had already been pitched under the great spreading planes, the nucleus of what afterwards developed into a camp for civil officials. I anxiously asked after my other friends in Civil Lines. The Irrigation Engineer with his wife and child, I was told, were crushed dead beneath the fallen roof of their house; a newly married Political couple who had just returned from their honeymoon, together with the bride's mother, were buried under the ruins of their bungalow in Lytton Road and almost certainly dead; two other Political officers and the Civil Surgeon had lost children; the Revenue Commissioner had been dug out alive but badly hurt from his completely flattened bungalow, in which a guest of his remained, almost certainly dead. Two ladies had been badly injured and the Civil Surgeon had a double fracture of the thigh, while another officer had received serious head injuries and would have to be invalided home. Other European casualties, including military officers and their wives and permanent residents of Quetta, were not known but estimated at 200 including 100 deaths; among these I afterwards found the names of several friends and acquaintances. The Indian death-roll was appalling and was already known to include many distinguished retired Government officials and men of substance in the town,

some of them men whose friendship I valued highly. The whole of Quetta had already been placed under martial law and rescue work had been in progress since 3.30 a.m.

My place was obviously back at Mastung, so after exchanging escape stories with surviving friends at the Residency I took my leave of the A.G.G. and drove round Quetta to see for myself the extent of the catastrophe. I went first to Cantonments. I found that by an extraordinary and most merciful dispensation the earthquake area came to an end about half a mile beyond the line of the Habib Nullah, the open drain which divides the City and Civil Lines from Cantonments. The houses, including Flagstaff House, immediately to the north of this boundary were as badly hit as any in Civil Lines; the next line of bungalows was definitely less affected, and beyond Hibbert Road I could find no external signs of serious shaking except fallen chimneypots. The Garrison Church, half a mile within the cantonment area, was standing and above all the British and Indian Military Hospitals were undamaged; this was particularly fortunate as the Civil and Mission Hospitals had been razed to the ground and most of the patients and staff killed.

Returning to the Civil area, I found myself in Bruce Road, the Piccadilly of Quetta. Though prepared, I could hardly believe my eyes. Scarcely two or three of the familiar shops were recognizable, and none were standing. Soldiers were on guard at many points and others were clambering about the ruins on rescue work, accompanied by a few—a very few—inhabitants. That was what struck me most forcibly. In this crowded city, in the middle of the day, with none of the houses inhabitable, only handfuls of people here and there could be seen. The rest were all there—under the great mounds of bricks and plaster and wood and iron sheeting. The appalling thought was that many of them must still be alive and, except for those lucky ones whom the toiling soldiers might rescue, must die a lingering death. I heard afterwards that the troops did dig out many hundreds of living persons from the ruins during the course of the next three days, as well as 3000 or more corpses. At least 4000 injured were treated at the Indian Military Hospital. Burials were to begin at 3 p.m. under military supervision; there was no possibility of separate graves, and trenches were being dug in selected areas outside municipal limits. Smoke from the funeral pyres of dead Hindus could already be seen ascending at several points. With a heavy heart I turned the nose of the car southwards and, picking up poor Gul on the way, drove back to Mastung.

By six o'clock I was back at my ruined headquarters, to find that my excellent servants had salvaged some bedding and other necessities as well as a little food for me and were themselves encamped under the trees. That night I was joined by my Assistant, Captain Bazalgette, and very glad I was of his company in my tent in the rose garden which was to be our home for the next few weeks. The evening and night were punctuated by earth-tremors of varying degrees of noise and violence. The next few days were spent by us working at fever heat in cooperation with the surviving Kalat State officials to convert chaos into some sort of order. We found that some 1125 persons had been killed in and around Mastung alone and another 2000 in the rest of

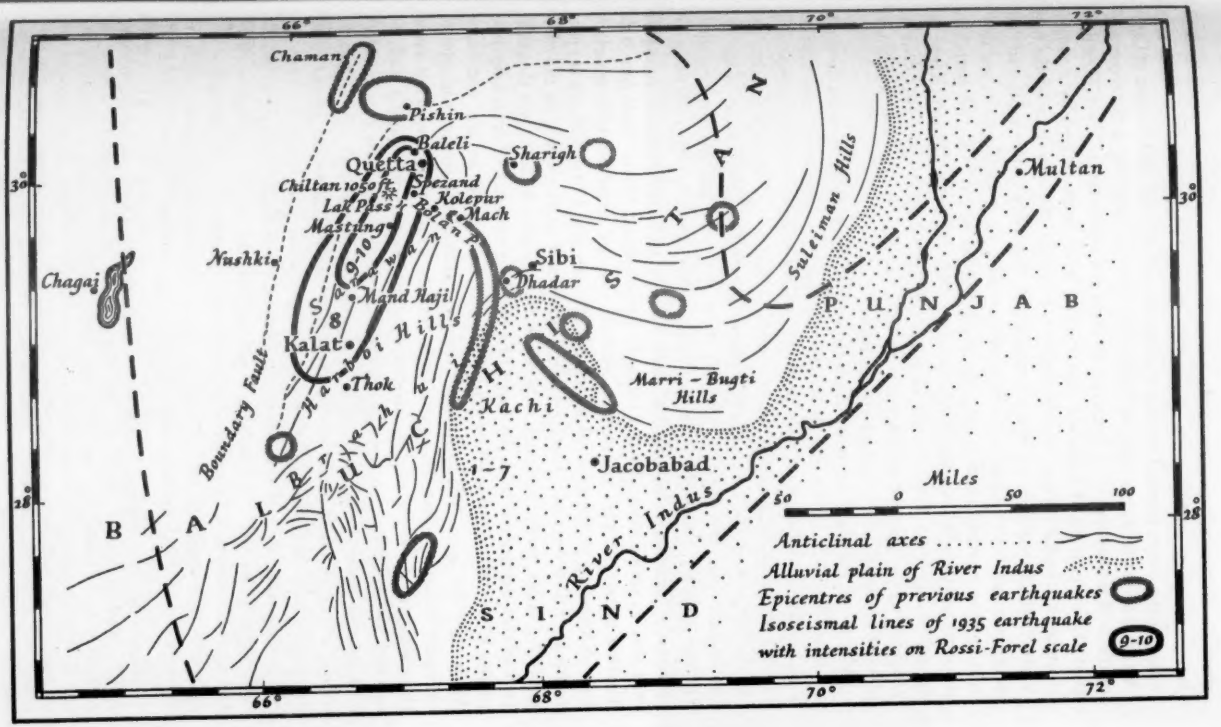
the earthquake area of the Kalat State. The bulk of the survivors needed only encouragement and what little assistance we could give them in the burying and burning of their dead and in the salvage of their property. All, Hindu traders and Muhammadan agriculturalists alike, worked with remarkable energy after the first shock had passed off. But hundreds were severely injured, and as I have already said there was only one small dispensary with an Indian doctor in charge to look after them. Hundreds more were destitute and had to be fed and sheltered. Last but not least, Mastung and other bazaars had to be protected by reinforcements of frontier militia, brought from far-off posts on the Afghan and Persian borders, against the marauding bands which roamed around the countryside. We did our best, but our resources were quite insufficient to cope with the situation, and had it not been for the prompt response of the military authorities at Quetta, the plight of Mastung and neighbouring villages from Kanak in the north to Mangochar in the south, a distance of some 58 miles by road, would have been sorry indeed.

It is time however that I turned to the scientific aspect of the earthquake, which perhaps interests this Society more than administrative details of the work of relief, salvage and reconstruction. Not being myself a seismologist—having in fact had seismology almost literally thrust upon me—I must content myself with bringing to the notice of Fellows the admirably lucid "Preliminary Geological Report on the Baluchistan (Quetta) Earthquake of May 31st, 1935," compiled by Mr. W. D. West, Assistant Superintendent, Geological Survey of India, as a result of his investigations in the earthquake area during the month following the disaster.[1] Mr. West had already been in Quetta some days when at my invitation he came to Mastung and spent five or six days touring round the affected area in Kalat State. I was fortunately able to spare the time to accompany him on more than one of his expeditions, notably to the fissure shown in Plate 8 and to the mud volcano, Plate 7. At Mr. West's request, detailed questionnaires were put to a considerable number of witnesses, including Brahui and Dehwar cultivators from numerous villages on the outskirts of the earthquake area, and the replies received were of material assistance to Mr. West in determining the limits of the epicentral zone. The "Preliminary Report" should be read with chapters I, II, VII, and VIII of Mr. West's "Report on the Baluchistan Earthquakes of August 25th and 27th, 1931."[2]

The diagrammatic map opposite, which is based on the maps appended to Mr. West's reports, shows the isoseismal lines of the 1935 earthquake together with the positions of the epicentres of the fifteen recorded earthquakes which have shaken Baluchistan since the middle of last century. It will be noticed at once that they are grouped in a curious way round a sharp re-entrant which exists in the mountain system of the province. The mouth of the Bolan Pass and the town of Sibi, only 450 feet above the sea, are at the head of this salient; the hills on its western flank rise to nearly 10,000 feet in the Kalat territory, while those on the eastern side are considerably lower, but still very rugged and precipitous. Now the mountains of Baluchistan are

[1] *Memoirs of the Geological Survey of India*, Calcutta, 1935, pp. 203–240.

[2] *Op. cit.*, vol. LXVII, Pt. 1, Calcutta, 1934.


66°
68°
70°
72°
30°
28°
Chaman
Pishin
Baleli
Sharigh
Quetta
Chiltan 10500 ft.
Spezand
Kolepur
Lak Pass
Mach
Mastung
Nushki
9-10
Sibi
Chagai
Mand Haji
8
Dhadar
Kalat
Thok
Harnai
Boundary Fault
Marri – Bugti Hills
Kachi
1-7
Jacobabad
Suleiman Hills
Multan
P U N J A B
B A L U C H I S T A N
S I N D
River Indus
Miles
0 50 100
Anticlinal axes
Alluvial plain of River Indus
Epicentres of previous earthquakes
Isoseismal lines of 1935 earthquake with intensities on Rossi-Forel scale
9-10

merely a southward branch of the great Tertiary system, of which the Himalayas are a part; and it is now generally accepted that the folds in these mountains "have been formed by the movement of the old stable mass of Central Asia towards the stable mass of Peninsular India, resulting in the compression of the soft marine rocks in between to form the mountains." Mr. West thinks that the re-entrant mentioned above may have been caused by a wedge of continental India jutting north-westward under the alluvium of the Indus Valley, which has held up the movement of the folds to the south-east. This process must result in a condition of special strain, and it is in just such a region that earthquakes might be expected to occur. Of the earthquakes prior to 1935 shown on the map, those of 1892 (Chaman), 1909 (Kachi), and 1931 (Sharigh and Mach) were all severe. That of 27 August 1931 destroyed Mach, Dhadar, and other villages with the loss of over 100 lives, and severely shook Quetta without causing any deaths.

Mr. West judges the maximum intensity of the Quetta earthquake of 1935 to have reached 10 on the Rossi-Forel scale at various points within an area about 68 m. long by 16 m. wide extending from Baleli just north-west of Quetta to Mand-Haji about 20 m. north of Kalat.[1] This area, marked 9-10 on the map, may be taken as the epicentral zone, and the focus of the 1935 earthquake may be located beneath its major axis and at a comparatively shallow depth (probably less than 5 miles). Mr. West writes with the utmost caution at this stage, but he evidently leans to the view that this earthquake was due to movement along a hitherto unsuspected thrust fault deep in the Earth's crust. In this connection special interest attaches to a remarkable line of fissuring in the ground which Mr. West visited first with me at a point some $2\frac{1}{2}$ miles west of Mastung. He describes it as extending on and off for about 65 miles, from the south side of Chiltan to near Kalat. Over the greater part of this distance it took the form of a crack or network of branching cracks in the soil. "Where the effect had evidently been most severe, just west of Mastung," he says, "the ground on the west side of the fissure had subsided abruptly about $2\frac{1}{2}$ feet, though a little farther south the subsidence was on the east side. In some places, instead of a subsidence or a gaping crack, the ground had been heaved up, the elevated portion being a foot or more high and several paces wide, indicating compression of the soil. To account for these varying phenomena, it seems likely that the motion of the ground during the earthquake was one of alternate compression and tension. Where the line of fissuring crossed the railway track that runs from Spezand to Nushki, at about 2 miles west of Mastung Road station, the track had been uprooted and the rails crumpled exactly along the fissure, although the latter was here comparatively insignificant" (Plate 3). As it could only be traced where the soil is of an alluvial nature, and no fracturing of solid rock was found, Mr.

[1] More than three-fourths of this area lies within the thinly populated territories of the Khan of Kalat, and it is only because the British Indian portion at the northern end included the capital of the province, Quetta, with a summer population of about 65,000 that the mortality was so high. At least 24,000 persons died in Quetta itself and another 3000 in neighbouring villages, while some 3250 more were killed in the Kalat State. From the point of view of lives lost, the earthquake must be accounted the most disastrous that has visited India within historic times.

7. The mud volcano at Thok

8. Fault scarp near Mastung

9. Mount Chiltan (10,850 ft.) before the earthquake

10. Mount Chiltan after the earthquake, showing scars of rock-falls

West considers this fissure to be a purely surface phenomenon affecting only the alluvium and not penetrating the solid rock beneath. He admits however that it coincides both in direction and in position with the long axis of the epicentral area, *i.e.* with the line of maximum disturbance. The inference, which Mr. West evidently hesitates to draw without further investigation, is that this is one of the comparatively rare cases of the formation of a "fault-scarp" during an earthquake. Well-known instances of this phenomenon, which is of the greatest importance in connection with the tectonic origin of earthquakes, include the fault-scarp formed in the Mino-Owari earthquake of 1891, the Assam earthquake of 1892, and the earthquake in Eastern Greece in April 1894. These fault-scarps or lines of fissuring are described in his 'Origin of Earthquakes,' by Dr. Charles Davison, one of whose most important contributions to seismology was his demonstration of the fact that most earthquakes are caused by sudden movements of the underlying rocks along an existing "fault" or crack in the Earth's crust. Usually these earthquake faults are so deep that they leave no trace on the surface, but in certain circumstances they do, and some of the surface phenomena in the cases mentioned above closely resemble those of the Chiltan–Mastung–Kalat line of fissuring. Dr. Davison writes as follows about the Mino-Owari fault in Japan: "When the vertical displacement in the plains or valleys was small, the path of the fault was marked by a rounded ridge of soft earth from one to two feet in height, which closely resembled what might be produced by the burrowing of a gigantic mole. When the displacement reached a height of several feet, the fault-scarp formed a cliff which, being of earth, soon crumbled down into a slope." [1] Again after the earthquake in Eastern Greece, in 1894, "a fissure was traced for a distance of about 34 miles running in an east-south-east and west-north-west direction through the epicentral district, and varying in width from an inch or two to more than three yards. That it was a fault and not an ordinary fissure, was evident from its great length, its uniform direction, and its independence of geological structure." [2] In Baluchistan itself, within 50 miles of Mastung, movement along the well-known Chaman fault revealed itself after the 1892 earthquake in a fissure or fault line traceable for 120 miles.[3] In the last case crumpling of the railway line took place very similar to that observed by Mr. West and myself near Mastung Road railway station.

The fault-line (if it is one) of the Quetta earthquake would if extended northwards pass under Chiltan, a conspicuous mountain rising to a height of 10,850 feet and composed mainly of limestone. On the morning of the earthquake and again after the violent after-shock of 3 p.m. on June 2, vast clouds of dust were for several hours observed rising from the sides of Chiltan. These were due to rock-falls on an enormous scale, one of which is clearly visible in one of the telephoto "shots" of my 16-mm. film. Plates 9 and 10 clearly show the difference in the aspect of the mountain before and after the earthquake. The white marking is due to the chipping and scraping effect

[1] Davison: 'Origin of Earthquakes,' p. 72.
[2] Davison: 'A Study of Recent Earthquakes,' pp. 340–1.
[3] *Mem. Geol. Surv. Ind.*, XXVI (1893), p. 57; *Geogr. J.*, vol. 9, p. 402 (1897).

of the rockfalls on the black oxidized surface of the cliffs laying bare the unweathered limestone beneath.[1]

Another interesting phenomenon which I heard about from Brahui tribesmen and took Mr. West to see was a "mud volcano" at a place called Thok, 12 miles south of Kalat and more than 30 miles beyond the southern end of the epicentral zone (Plate 7). The neighbourhood is desert except for a spring and the shrine of a local saint about a mile away. The mud buildings of the shrine collapsed on the night of May 30–31, killing fourteen out of the seventeen persons sleeping there. The survivors told me that a neighbouring hillock burst with a loud roar, and when day dawned clouds of smoke (probably steam) were rising from it and hot mud oozing in large quantities from a crater at the top. The flow continued until noon on May 31. Mr. West, describing the hillock in his "Preliminary Report," said that he recognized at once that it was an old "mud volcano" which had burst into eruption again. "The old mud," he says, "was a dirty brown colour, whereas the new mud was a bluish-grey, so that the new flows showed up very clearly against the old. At their edges the flows were mostly less than a foot thick, though they were probably thicker near the vent." The maximum breadth of the mud-flow, which when we saw it had dried up and caked with the appearance of lava, was 300 yards and the height of the hill about 100 feet. These "mud volcanoes" are common on the Arakan coast of Burma, and are also found along the Mekran coast of southern Baluchistan. The term is really a misnomer, as they are not thought to be connected with volcanic activity. Hobbs [2] definitely places them in the category of earthquake phenomena and mentions similar exudations of plastic mud during the earthquake of 12 February 1902 at Chemakha, in Russian Turkistan. The mud formed high hillocks of pasty material surmounted by craters, and these in turn were disturbed and fractured by subsequent movement on the same fault planes.

A feature of the Quetta earthquake was the complexity of the ground-motions. Several witnesses say that they felt horizontal shaking both from north to south and from east to west, as well as vertical movement. Four stone monuments examined by Mr. West in the Quetta cemetery were found to have rotated on their bases, one to the extent of no less than 43° anti-clockwise.[3] The movement also varied from place to place, but was everywhere rapid, "like a dog shaking a rat," as a Brahui villager near Mastung graphically described it to me. The most interesting account of the actual shock comes from an officer who happened to be marching with his men on night operations 4 miles north of Quetta on the Baleli road. The main shock, according to this account, "came from the south, and may have been preceded very slightly by the sound, which resembled the sound heard in an Underground station as a train approaches in a tunnel, rapidly increasing to a roar.

[1] The "smoking" of Chiltan on May 31 and June 2 seemed to support the belief, universal among the local population, that the mountain had become a volcano and that the overwhelming of the survivors by its eruptions was only a matter of time. This belief greatly facilitated the task of the military authorities in evacuating the surviving population to Sind and the Punjab.

[2] 'Earthquakes,' p. 134.

[3] Possible causes of this interesting type of earthquake phenomenon are discussed by Davison, 'A Study of Recent Earthquakes,' pp. 293–6.

Those who did not lie down at once were either flung down or were just able to stagger about. The ground heaved as in a rough sea, or in the way a small boat behaves in the wake of a larger steamer. The direction of the waves was mainly from south to north, but occasionally from east to west. The motion subsided gradually, fading away towards the north-west, accompanied by the sound of falling rocks." [1] Others present described also how the trees on either side of the highway swayed violently to and fro until their branches swept the ground. A motor-driver in the employ of the Khan of Kalat told me that he was driving into Quetta on the night of the earthquake and had reached a point about 11 miles from the town, when the car suddenly got out of control and he had the utmost difficulty in bringing it to a standstill without overturning into the ditch. He then realized that the earth was shaking violently. Looking up, he and his companions saw flashes of light running along the flanks of the mountains on both sides of the valley.[2]

A point in connection with the earthquake which is not mentioned in the "Preliminary Report" is that it occurred at new moon. I understood from Mr. West that the idea that earthquakes occurred more frequently at new or full moon was no longer regarded seriously. There is however a considerable body of opinion in favour of lunar periodicity, and of tidal stresses as a secondary or contributing cause of earthquakes. The question is discussed very fully, with a complete bibliography, by Professor Leo Cotton in his paper on "Earthquake Frequency and Tidal Stresses," in the *Bulletin of the Seismological Society of America*, vol. 12 (1922).

Of more practical interest, perhaps, is the question of the possibility of further earthquakes and their location in Baluchistan. We have already seen that all the earthquakes which have been recorded in the province during the last eighty or more years have had their epicentres in or near the curious re-entrant in the alignment of the mountains, the apex of which is the Bolan Pass (see map facing p. 420). Actually they have all occurred within a radius of 140 miles from Dadar, a village in the Kalat State 16 miles west of Sibi. But, as Mr. West points out, the focus of an earthquake has never occurred at the same place as that of a previous one. Each major shock has relieved the stresses which have been accumulating in the underlying rocks in that area. If the "seismicity" of Baluchistan were connected with volcanic activity it would be a different matter. But there is no sign of volcanic activity nearer than the almost extinct Kuh-i-Taftan, 400 miles to the west. In all probability therefore Quetta is one of the safest places within the earthquake area for a considerable time to come. But there is no certainty in the matter, and in deciding, for compelling reasons into which I need not enter here, to rebuild the cantonments and civil lines on the old sites the Government of India have taken other factors also into consideration.[3] The first of these is the great progress which has recently been made in Japan and the United States

[1] West: "*Preliminary Report*," pp. 212–3.

[2] Luminous phenomena have frequently been reported in earthquakes, but the evidence is not definite enough to furnish data for an explanation. In the present case the most likely explanation would seem to be sparks from the friction between moving rocks on the steep, dry hill-sides.

[3] See Government of India Press Communiqué of 23 December 1935.

along various lines of research connected with " earthquake-proof" building. In chapter VII of his "Report on the Baluchistan Earthquakes of August 25th and 27th, 1931," already cited,[1] Mr. West summarizes the conclusions arrived at in those countries and applies them to Baluchistan. Further lessons to be learned from the 1935 earthquake are to be found in the "Preliminary Report," section 11. It has been proved in Japan and America that by applying certain principles of construction and using suitable materials, it is possible to build houses of two or more storeys up to a maximum height of 100 feet which are capable of resisting the most violent shocks hitherto recorded.

The main principle is rigidity. It has been found that in most earthquakes the period of oscillation of the ground is one to one and a half seconds; accordingly, buildings must be constructed with a much shorter period, say 0·5 or 0·6 seconds, so that the whole structure will move as one unit. Foundations, especially in loose alluvial ground, should be of solid concrete at least 3 feet thick. The shape of the building should be compact, with few irregularities such as long unsupported wings, high gables, copings, tall heavy chimneys, towers, porches, and so on. Internal walls should run in both directions, and be so united with the external walls that they form one piece with them. Roofs should be light, with the weight evenly distributed along the walls. Above all, the walls supporting the roof should be strong and homogeneous, as nearly "monolithic" as possible. In this connection Mr. West has much to say on the subject of the "mud mortar," or rather paste made with sand or powdered bricks instead of lime, the use of which has become almost universal in Baluchistan during the last fifteen or twenty years. After the 1931 disaster Mr. West wrote: "The custom in Baluchistan of using large limestone blocks set in mud mortar is about as unsatisfactory a method of construction from an earthquake point of view as could possibly be devised. It lacks completely any sort of homogeneity, and when an earthquake occurs the heavy blocks simply slide over the mud mortar, and the wall collapses. . . . There can be little doubt that an earthquake of the severity of the Kangra Valley earthquake of 1905, or even one considerably less severe, would lay in ruins the

[1] Mr. West cites the following American and Japanese authorities: H. M. Hadley, "Earthquake-proof Building Construction as revealed by the Japanese Earthquake," *Bulletin of the Seismological Society of America*, 14, p. 6 (1924); H. D. Dewell and Bailey Willis, "Earthquake Damage to Buildings," *op. cit.* 15, p. 282 (1925); Tachu Naitu, "Earthquake-proof Construction," *op. cit.* 17, p. 57 (1927); H. M. Engle, "The Earthquake Resistance of Buildings from the Underwriter's Point of View," *op. cit.* 19, p. 86 (1929).

In addition to the above, J. H. Freeman's recent paper on "Data for Construction of Earthquake-resisting Structures" (*op. cit.* 20, pp. 67 ff. (1930)) will be found of particular interest. The writer emphasizes the uncertainty of the data on which the prevailing standards of earthquake-proof construction are based, and urges the necessity of establishing strong-motion accelerometers of simple design in all earthquake areas. He describes recent Japanese shaking-table experiments, and researches into such questions as the natural or "preferred" vibration of the ground in particular localities, the behaviour of tall buildings artificially oscillated, and the measurement of infinitely small earth-tilts with a view to the possible prediction of earthquakes in the neighbourhood of known faults. The Ishimoto tilt-meter, it seems, can measure a tilt of one-thirtieth of a second of arc, which is equivalent to one-tenth of an inch on a radius of 1 mile!

greater number of the buildings in Quetta, so poorly are they built." [1] This prediction proved only too correct. The manner in which the houses we lived in crumbled away like so much dust under the weight of the roofs was a revelation to most of us who went through the Quetta earthquake.

For future building, Mr. West recommends a frame of steel girders with walls of hollow concrete blocks.[2] In this connection it may be mentioned that after the 1931 earthquake one department, the North-Western Railway, with commendable foresight decided to reconstruct their damaged buildings on earthquake-proof lines. Several bungalows, one of which is seen on Plate 5, were built of vertical and horizontal rails with a panelling of bricks. Another method tried was to make brick walls of normal thickness and reinforce them with expanding metal laid horizontally between the bricks at every fourth course. None of the completed earthquake-proof bungalows of the North-Western Railway fell, or were even appreciably damaged.

Another factor which influenced Government in their decision to rebuild Quetta on the same site was the remarkable degree of immunity enjoyed both in 1931 and in 1935 by the north-eastern portion of the cantonment area, which is situated upon dry alluvium. The only serious damage done to cantonments was in a belt about half a mile wide immediately adjoining the city and civil lines, and even here there was a rapid decrease in intensity towards the north-east. Throughout the earthquake area destruction was at a maximum on water-filled alluvium. This phenomenon, which has been observed in most great earthquakes, is explained as follows in the "Preliminary Report": "In water-filled alluvium the pore spaces are filled with water, and the rigidity of the water transmits the shock with full force. But in dry alluvium the pore spaces are occupied by air, and this has a cushioning effect on the shock, damping it out considerably." [3]

It was accordingly decided [4] during the cold weather following the earthquake to clear completely the site of ruined Quetta, leaving a framework of roads, drains, and electric and water mains on which the plan of a new and better city could be laid out. The width of many of the roads will be increased; stringent building regulations will be laid down and enforced; the lay-out of the city and the designing of government buildings will be entrusted to experts in town-planning and earthquake-proof construction whose services have already been engaged. The work is proceeding apace; with the help of huge drag-line excavators, scores of motor lorries, and a narrow-gauge

[1] *Mem. Geol. Surv. Ind.*, LXVII, p. 80.

[2] West, "Preliminary Report," 1935, p. 234.

[3] *Ibid.*, p. 230. See also *Bull. Seism. Soc. America*, 23, pp. 43–56 (1933), for an account of the Long Beach earthquake of 10 March 1933. This earthquake was very similar in area, intensity, and effects to the one with which we are dealing. The following passage is worth quoting: "As on previous occasions, much of the spectacular damage was due (1) to bad natural ground or grading—made land, or deep water-soaked alluvium or sand; and (2) to bad or unsuitably designed construction—bad foundation structures, little or no provision against the stresses caused by earthquakes, bad or unsuitable materials, bad workmanship, or some combination of these factors. . . . More than usual this earthquake 'picked on the cripples.' The amount of the structural damage was out of proportion to the energy and violence of the shock."

[4] Government of India Press Communiqué of 23 December 1935.

railway the old Quetta is being dumped bodily into borrow-pits in the surrounding desert. In its place it is hoped to create a new Quetta on modern scientific lines with adequate protection not only against possible future earthquakes, but against malaria and other epidemic diseases. A crore of rupees (£750,000) has already been spent, and the cost of reconstruction is estimated at about a crore a year for at least seven years.

Thirty thousand people killed, thousands more seriously injured, untold ruin and misery caused to the survivors, eighty million rupees lost to the Indian taxpayer—all done in twenty seconds, because man does not yet know how to locate strains in the crust of his planet and predict their breaking-point.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: My Lords, Ladies and Gentlemen,—I think most of you know Mr. Skrine quite well. He has received an Award of this Society and has been frequently on our platform. Wherever he has been in the course of his service, alike in Central Asia, Turkestan, and Persia, he has always been at pains to study the country from a geographical point of view. He is also a skilful photographer as those of you will have realized who saw the film he recently showed the Society. He is the son of a great traveller who came across Asia fifty or sixty years ago, and it is a pleasure to welcome here Mrs. Skrine, his mother, who has flown over from Paris in order to be with us to-night.

Mr. Skrine is going to give us an account of his experience during the Quetta earthquake. We also have with us Sir Norman Cater, who was Agent to the Governor-General at Quetta at the time and himself had a very narrow escape. I hope that he will give us a brief account of his own experience, and there are others in the audience who will do likewise.

I now ask Mr. Skrine to deliver his lecture.

Mr. Skrine then read the paper printed above, and a discussion followed.

Sir NORMAN CATER: I have been asked to say a few words as to my personal experience in the Quetta earthquake, and it is just as well to lay emphasis on "few." If I once began talking about the Quetta earthquake I could go on for hours.

As to my own personal experience in the earthquake, I can hardly tell you anything. It was my fortune, or misfortune, during my time as Agent to the Governor-General to experience two earthquakes, one in 1931 and the one about which you have heard this evening. I would however like to contradict a report which appeared in at least one English newspaper that in the earthquake of 1935, which happened at 3 o'clock in the morning, I was entertaining a gay party of guests. Actually I was fast asleep. My first conscious recollection was "Well, this is another earthquake and it is very much worse than the last one. The sooner I get out, the better." I tried one door which led to the verandah. It was jammed. Then I managed to get out through the porch which had fallen down, and how on earth I got out alive I simply cannot tell you. After that I went to the bazaar and saw that the whole place was wrecked. However I cannot now go into all that.

There were three crowning mercies of the last Quetta earthquake: firstly, that the water supply was not affected; secondly, that the railway stood up to it; and thirdly, that the cantonment was unaffected and we had the assistance, as you have heard, of the military. You must all have read, and heard too, what General Karslake and his soldiers did for us. It is perfectly certain that but for

them there would have been far greater loss of life. There would have been a terrible outbreak of looting and disorder, and an almost inevitable outbreak of epidemic disease. We were saved from all that by the soldiers.

But let us also remember what was done by the civilians of Quetta. When I say civilians I mean Indian as well as British, and non-official as well as official. There were some who succumbed to the strain. That cannot be denied. I am the last to criticize if some did suffer from the reaction, but for one who did there were ninety-nine who rallied round and volunteered their services and did everything they possibly could.

You may perhaps have formed from the pictures some idea of the magnitude of the disaster which befell Quetta but, as I have said to many people, no one can realize what happened that night unless they were there and saw and experienced it. Those who came to the Residency within an hour or two of the earthquake and volunteered their services were people who had lost their relatives, lost their houses and their all and, with scarcely an exception, they came forward and tried to do their best not only then but during the weeks that followed. Let us remember that. As I say, it was not only the British but Indians also who volunteered in that way. So if the Quetta earthquake was a disaster of the first magnitude it was also one more example of the way in which British and Indians can and do work together for each other's welfare.

The PRESIDENT: I am sure it would be of interest to you to hear some comparison between the type of earthquake at Quetta and the similar calamity which occurred at Messina some years ago. I will ask Admiral Sir William Goodenough to say a few words on that subject from the tablets of his memory.

Admiral Sir WILLIAM GOODENOUGH: You may be interested to hear some comparison between this tremendous upheaval at Quetta and that at Messina, both of which caused such a great amount of human suffering. It always surprises me that there is not a greater change of formation of the actual Earth's crust in view of the immense pressures that are exerted by Nature on such occasions. I was at Messina within forty-eight hours of the great earthquake. We were naturally warned to exert the greatest possible vigilance as there would probably have been great changes in the soundings and depths of water. There were actually not any at all. When one thinks of the great stresses and pressures put on things, sufficient to part the *Exmouth's* 2½-inch chain cable by some sudden jerk, this is astonishing.

It is interesting to recall that the houses in Messina and on the coast opposite were, curiously enough, not built to withstand earthquakes. They were very high. It appeared as if the whole movement was, as it were, on a hinge, for as we walked along what had been streets and were then covered with rubble we could see where the houses had apparently moved one way and back again; the front wall had fallen out and the whole place had opened like a child's dolls' house. Where the bed had not fallen out of the room into the street one could see a man's coat and trousers hanging on it.

Mr. Skrine spoke of those who had been for many hours entombed at Quetta and found unhurt. I remember one case particularly of a woman entombed in Messina. There was a stream of water running through the spot where she lay which had been formed into a sort of big cave. The woman was rescued after thirteen days. Not only was she alive though much emaciated, but her child, born whilst the woman was entombed, was alive and perfectly well.

There is one remark I would add, sir, and I hope I shall not be taking something from your speech. Sir Norman Cater spoke of three crowning mercies of the Quetta earthquake. There was one other which I am sure we all feel with great pride, that was that there were men like Sir Norman, like General

Karslake and others there to show great courage, devotion and absolute self-sacrifice without any thought of themselves.

The PRESIDENT: It has been a great privilege, as I am sure you will all agree, to have heard at first hand the individual experience of these two British officers who, fortunately, survived the earthquake. As Sir Norman Cater said, it is quite impossible for anybody really to comprehend the awfulness of the tragedy unless he or she was on the spot. As Admiral Goodenough has just remarked, such happenings at any rate provide an object lesson, and innumerable opportunities for courageous and selfless assistance to others in distress.

I now ask you to join me in thanking the lecturer. As you have realized, aided by his remarkable photographs he has been able to put before us, as far as anybody possibly could, a thoroughly realistic idea of the terrible tragedy. Please join me in thanking him very heartily.

NIVATION, RIVER GRADING, AND SHORELINE DEVELOPMENT IN SOUTH-EAST ICELAND

W. V. LEWIS

THE Cambridge Iceland Expedition 1932 (1) enabled the writer to examine both the coastal and inland topography of South-East Iceland. The problems arising out of this visit which are to be discussed in this paper comprise three independent aspects of geomorphology, but they are here grouped together because the observations were made in the same region.

Incipient Corries.—The mountains of South-East Iceland present a wealth of features which seem to be intermediate in form between those due solely to water action and those due to ice. There are a few mature glacial valleys, some of which still carry ice tongues fed by Vatnajökull, but the signs of true mountain glaciation with its valley steps, reversed slopes and corrie lakes are absent. Some of the valley heads are rounded but have the thalweg of a normal stream, others are V-shaped but yet too wide for simple stream erosion. A cursory glance might suggest that certain of them, at least, are normal water-worn valley heads, but in view of the prevailing steepness of grade this

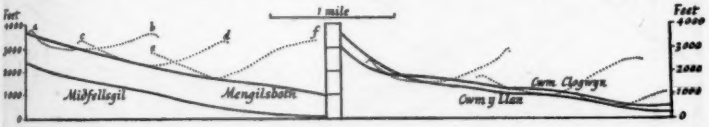


Fig. 1 *Fig. 2*

interpretation cannot hold good. In the field the sight of the present streams cascading down miniature gorges incised in the floor of the wider valleys affords the clearest evidence of the inadequacy of an explanation appealing solely to stream erosion.

The longitudinal profiles of two typical rounded valley heads, Mengilsbotn and Miðfellsgil, are represented in Fig. 1 and the lines *ab*, *cd*, and *ef* are cross sections at the points where these curves make contact with the longitudinal profiles. Fig. 2 shows, for comparison, the profile and three cross sections of Cwm y Llan and the profile of Cwm Clogwyn, both in the Snowdon district. The cross sections are similar but the longitudinal profiles quite different, those of the Welsh cwms being steeper at the heads and showing a distinct step where they join the main valleys, whereas the Icelandic examples present a slightly concave curve which only flattens out as sea-level is approached. Apart from these major valley heads the mountain slopes are everywhere scalloped by small hemispherical hollows, irregularly spaced and showing all variations in size from a few hundred yards to over a mile across. It is these latter features which concern us at present. An advantage which the area possesses for their study is that, even in a short spell of two months, one can examine forms below, at, and above the snow-line, whilst during the retreat of the snows in early summer the processes which seem to play a major part in their evolution can readily be witnessed.

The incipient corries are far smaller than the valley heads already described

and are generally perched high up on the mountain sides. A series A, B, C, D, E is shown in Fig. 3, A is visible in the top right-hand corner of Plate 1, and B and C just below the sky-line in the centre of Plate 2. Where the gradient is sufficiently low the contours are added (Fig. 3) at 20-metre intervals to show the form of the surface more clearly. Of first importance is the fact that the hemi-spherical configuration so perfectly developed in the larger features of Fig. 1 is already apparent.

In comparison with the copious literature on the mature stage of cirque formation, little reference has been made to the early stages, and this aspect of the subject is our chief concern. Hobbs (2) remarks upon this omission and attributes the solution of the problem to Matthes (3). The latter assumes that a snow-bank can, without movement, deepen any slight depression by a process termed "nivation." This process includes the excessive frost

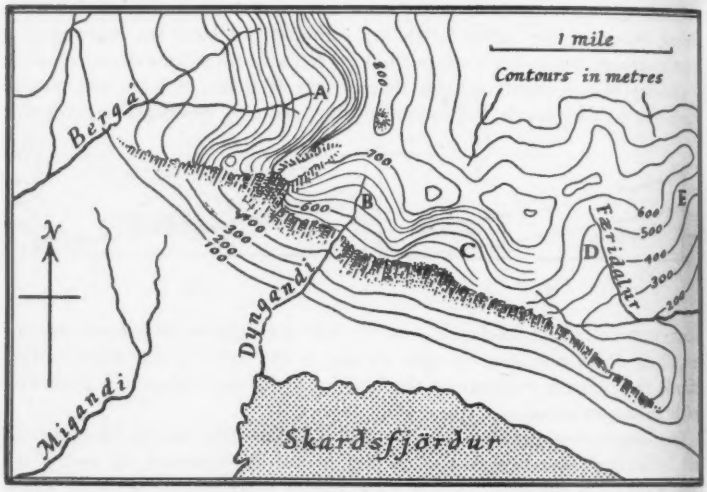


Fig. 3

action round the receding margins of a snow-drift in summer which comminutes the debris and this, in turn, gets washed away by the melt-water. Matthes (4) also refers to frost action loosening material and thus aiding its transport down the valley sides. Nielsen (5) discusses the action of small summer snow-patches in south Iceland. They keep the ground below moist during the period of melting, and so the downhill creep of loose material is accelerated beneath the snow patch. The resulting ridge below moves downhill each season. This accelerated creep plus the frost action of Matthes seem largely to account for the features noted. Melt-water released from the upper part of the snow patch trickles down underneath the snow in summer, this freezes at night or during cooler spells and thus enables vigorous frost action to take place probably under the whole of the snow patch. Once broken loose from the solid rock, the material tends to travel downhill by solifluction, enhanced by the lubrication of a generous supply of moisture

F. W. A.

1. *Near Hornafjörður: slopes subdued by solifluction on left, basaltic screes on right*

W. V. L.

2. *Incipient corries above on old sea cliff, Hornafjörður*

F. W. A.

3. *Ice-covered upper slopes of a mountain on S. edge of Vatnajökull*

F. W. A.

4. Slopes smoothed by solifluction and cliffs of basaltic lava, N. of Vatnajökull

W. L. S. F.

5. Distributing pattern of the river Staðara

beneath and in close proximity to the melting snows. The moisture often tends to be concentrated at the surface owing to the presence of an underlying impervious layer of frozen subsoil. Hence material is removed from a small initial hollow where the snows linger, far quicker than down the neighbouring hillside, whose debris-covered slopes are lacking in water for a greater part of the year. Provided this disparity in the rate of movement of superficial debris is maintained, it seems that, given sufficient time, this action would increase the size of an initially small hollow until the thickness of the accumulated snows is sufficient for ice to form. Views such as that shown in Plate 3 suggest that in Iceland this stage is reached when the *névé* is relatively thin. For the ice shown in the photograph originates in a purely local *névé* region of little more than a square mile in area and of no great thickness, judging from the frequent appearance of solid rock.

It has been suggested that nivation beneath a snow patch does not continue when the latter assumes sufficient proportions to insulate the ground from atmospheric changes of temperature. This argument however ignores the possibility of melt-water trickling down beneath the snow patch on a hot or a rainy day. In Iceland we repeatedly witnessed excessive melting, both in the middle of the ice-cap and at the edges where black, basaltic dust blows on to the ice, absorbs radiation, and still further accelerates the melting. Quite small streams were observed to melt their way down through the ice-cap where it must have been many hundreds of feet thick. Finally the sight of swift rivers, swollen to a mile or more in width, emerging from the ends of the glaciers, confirmed our numerous impressions of the potency of summer melting. Thus even large, permanent snow patches under glacial conditions might well have given rise to sufficient melt-water in summer both to free and to lubricate the underlying debris by melting the snow in immediate contact with the floor. Smaller patches which disappear in summer, as do those in most of the area under present climatic conditions, give up the whole of their mass in melt-water each season and so expose their floor temporarily to this form of wastage. It is assumed that the features described evolved, for the most part, under glacial conditions, but that the processes then operative still continue to a lesser degree under peri-glacial conditions. Högbom (6), Wright (7), Taylor (8), and De Martonne (9) all refer to nivation hollows developing into cirques, and Priestley (10) agrees that snow drifts deepen the pockets in which they lie, though he does not think that this would continue far enough to form a true cirque.

The Icelandic examples suggest that the arcuate pattern of the contours of the incipient corries or nivation hollows evolves at a very early stage, and as this form is so characteristic of the maturer cirque it is pertinent to attempt to trace its origin. Many of the snow pockets probably started in preglacial or interglacial times as the heads of small tributary streams high up the mountain sides. The V-section of a normal valley seems to be due to the ability of the stream to move the volume of debris supplied to it down a more gentle gradient than this material can creep down the valley sides. This produces both a V-section and a "V-ing" of the contours, as shown in Fig. 4. When the valley becomes snow-covered for all or part of the year, the relative efficiency of these two modes of transport is radically altered. The supply

of moisture beneath the melting snow accelerates the creep down the valley sides and tends to choke the stream channel with the transported material. This sheet-flow down the valley sides and head becomes the chief transporting agent and, assuming the rock type and amount of moisture to be approximately the same under the different parts of the snow bank, the rate of movement will depend largely on the steepness of the slope. The V-shaped valley head has the steepest slopes down the sides and accordingly solifluction will be most active in this zone (see arrows Fig. 4). This will lead to a widening of the valley and thus an approach to similar gradients in section and in longitudinal profile, which causes the contours to follow concentric arcs rather than the "V-pattern."

The slopes of the nivation hollows however flatten somewhat towards the

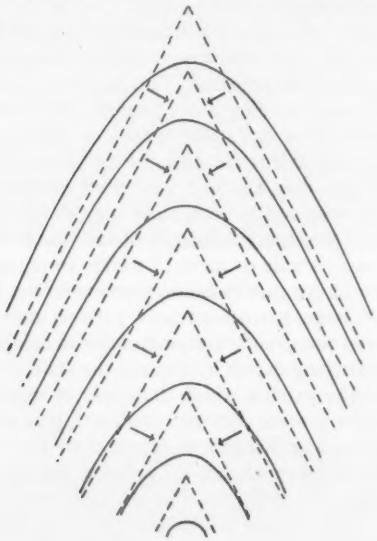


Fig. 4

centre of the valley. This is probably due to solifluction having been most active on the lower slopes (*a*) because of the concentration of melt-water and (*b*) because in temporary snow patches these parts are the longest covered with snow each season. The ideal hemi-spherical form is naturally diversified by the differing resistance of rock type and structure to erosion, but only to a minor degree, no doubt owing to the simplicity of structural types, the strata over the whole area consisting essentially of more or less horizontal basalt flows and tuff partings.

The moulding of waste-covered slopes.—An important nivation feature which is very evident in Iceland has also been noted by Matthes (11). Slopes which are not sufficiently steep to cast off their mantle of debris show a general smoothness and waviness of outline, at a distance suggestive of glacial moulding. This contrasts strongly with the steeper slopes of the coastal plain

cliffs and the higher frost-shattered peaks and ridges, in which the hard angles of the basalt outcrops rise tier upon tier above scree slopes which themselves follow grades of almost machined uniformity. Plate 1 shows this contrast between clear-cut cliff and scree and the smoothed slopes of the multiple valley head of Miðfellsgil, in which the basalt outcrops appear only in sub-relief. This feature was most strikingly developed on the northern borders of Vatnajökull. The eastern slopes of Kveragil are shown in Plate 4, in which the moulding of the slopes adjacent to the sky-line is typical as also is their abrupt truncation by the gnarled lava masses forming the cliffs. These smoothed slopes are very much gentler than those of the true screes in the left of the photograph. The surfaces illustrated are composed of both coarse and fine material and are entirely bare of vegetation. Thus the general absence of entrenched watercourses, in spite of the exceedingly heavy precipitation, is all the more remarkable.

The smoothness is probably due to active solifluction during the spring and early summer when the winter snows are melting away. We witnessed, much to our discomfort, the completely waterlogged nature of these slopes on such occasions. The downhill creep of material is then accelerated on the steeper slopes and retarded on the gentler and therefore it tends to replace hard angles and abrupt slopes by sweeping and undulating curves. Thus the irregularities in the underlying basalts are effectively concealed beneath a more uniformly sloping surface of debris. These rounded curves probably develop on a large scale only so long as the snow covering retreats along a straight or gently curving margin. If hollows are present in which the retreating snows tend to linger, the action already described tends to deepen the pockets and so to modify the land surface.

The grading of fluvio-glacial streams.—Some 40 square miles of the south coastal flats within the area visited by the expedition consist of unvegetated outwash gravels. The speed of flow of the rivers over these graded flats was quite remarkable. Some were so swift that even the sure-footed Iceland ponies could not resist the force of the stream if the water once reached their bellies, this being a constant source of fatal accidents. These gravel flats penetrate into the mountains along the main glaciated valleys and here they offer some instructive examples of river grading.

The flat, gravel-covered floor of Kalfafellsdalur has a total length of 10 miles from the lagoon to the glacier front and an average width of over a mile. The Director of the Danish Geodetic Institute was good enough to furnish us with a large number of spot heights in addition to those on the published map. The mean error for these heights is given as 2 metres. With the aid of these the gradient of Kalfafellsdalur floor has been constructed (1 to 21, Fig. 5). The spot heights used were all immediately alongside the river or its distributaries. The grade corresponds very closely to the straight line drawn in the figure, even though the large vertical scale is chosen to exaggerate any discrepancies. This gradient is maintained alike by large and small distributaries over a course of 10 miles involving a fall of over 450 feet and with a gradient three times that of the Spey, one of the swiftest British rivers, over a corresponding reach. This difference between the gradient of the two rivers, each with a distributary pattern, is most significant and seems to be

Fig. 5

due to a difference both in the coarseness and abundance of the material available for transport.

Oldham (12) has shown that, with a fully loaded stream, the gradient of equilibrium is steeper with coarse than with fine material being transported, but although the fluvio-glacial gravels of the Icelandic river appeared to be somewhat coarser than those of the Spey, the difference is not commensurate with that of the two grades. On the other hand the material available for transport is far greater in the former case, for whereas the gravel flats of the Icelandic rivers greatly exceed a mile in width, those of the Spey vary between 200 and 700 yards, beyond which are vegetated banks. Oldham (13) also examined the gradient produced by sending down a channel water mixed with varying proportions of sand, and the resulting figures indicate that the final gradient of a stream bed will vary with the amount of material available for transport. This factor would seem to account for the very different grades of the above two rivers. So much energy is used up in transporting the abundant fluvio-glacial gravels that the Icelandic river can only carry this load provided the gradient is steep; material is therefore deposited in the upper reaches until the required gradient is attained. This river has a far greater flood discharge than the Spey, and thus, according to Gilbert (14), it should have a correspondingly lower grade, also the various distributaries, whatever their size, produce roughly the same grade. Thus the streams seem to ignore the usually important influence which discharge exerts on grade.

An increase in discharge alone is so effective in increasing the velocity and thus affecting the grade of British rivers that it is advisable to consider possible reasons for the very different behaviour of the Icelandic streams.

Let ABC (Fig. 6) represent the cross section of a typical British river with a well-defined channel between consolidated banks. The forces acting on the water are gravity tending to impel the water downstream, and friction on the banks tending to resist the motion. For a given velocity, friction is proportional to the wetted perimeter ABC. Suppose the discharge increases so that the cross sectional area is doubled, that is, to DBE. The perimeter DBE is only slightly longer than ABC, and therefore friction is increased by only a small amount whereas gravity is doubled.

Hence the river at level DE moves with considerably greater velocity than when at level AC. With the Icelandic streams under discussion the case is very different. The river surfaces are always very near to the level of the surrounding gravel flats and an increase in size does not involve a great increase in depth, but merely a spreading over and cutting into the adjacent unvegetated flats, causing only an increase in width. Members of the expedition rode across nearly 20 miles of distributary streams when summer melting was at its height and the individual streams varied from a few yards up to a mile in width. Yet on only one occasion were the small Iceland ponies obliged to swim, and even this deep channel was barely 30 yards wide and was avoided by the pack ponies which crossed a few miles upstream.

Thus, doubling the cross section of such a stream changes its section from FGHK (Fig. 7) to LMNO, and this involves approximately doubling the wetted perimeter. Accordingly both the force of gravity and the resistance due to friction are doubled, and so the velocity remains sensibly the same. Thus differences in discharge have relatively little effect in changing the velocity of the streams, and hence small and large distributaries alike attain a similar gradient, which is chiefly a function of the amount of material available for transport. Further, the Icelandic streams, even in times of flood, find sufficient material readily available for them to become fully loaded and their velocities

Fig. 6

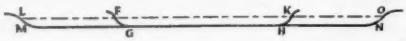


Fig. 7

correspondingly reduced. British streams in times of flood might well not find sufficient loose material on their beds to load them fully, in which case the velocity increases until wear and tear on the consolidated banks yields material which partly makes up for this deficiency.

The departures from the straight line in the thalweg Fig. 5 are themselves interesting. Those near the lagoon (1, 2, and 3) are consistently low because as the contours of the valley show, the section of the river below point 5 had recently swung over from a well-developed fan on the west side of the valley to a lower course on the east side. Just above 5, at points 6, 7, and 8, the river still followed an old course down the centre of a fan. Thus the local gradient seemed to be more dependent on the age of the particular stretch than on the simple fan and reach arrangement described by Oldham (15). From point 8 upstream the fans and reaches can be ascertained only in the distributary pattern and not in the profile. Point 12 is anomalous, but points 20 and 21 indicate a very real steepening of grade as the glacier front is approached. A large tributary enters at 20, whose gravel-covered floor has a still steeper grade to point 22. Thus the gradients might appear on first consideration to illustrate the truth of Gilbert's assertion (16) that "declivity bears an inverse relation to the quantity of water." The correspondence between the river junction and change of gradient however is not close enough to allow the complete acceptance of this explanation. Also this steepening of grade near the glacier is evident on nearly every outwash stream in South-

East Iceland, whether or not several streams unite to form the main stream. It appears that the amount of debris delivered at the glacier front, both as moraine and outwash gravel, overloads the stream for some distance, beyond which, having deposited some of their load, they proceed on a lower and more or less uniform grade. This implies that there is an excess of deposition over the steeper initial grade before the gentler gradient is reached, *i.e.* the gravel plains are still in a state of aggradation. This aggradation might be temporarily accelerated by the excessive melting associated with the present general retreat of the glacier fronts in South-East Iceland (17).

Profile 23–26 (Fig. 5) represents that of the floor of Staðardalur (Plate 5), the eastern neighbour of Kalfafellsdalur, which was also gravel-covered up to the glacier front in 1903, but by 1932 the glacier had retreated some distance up a steep gorge. This profile is distinctly concave and so apparently has not reached such a mature stage of gravel-infilling as its greater neighbour. The third profile, 27–34, represents the floor of Laxardalur, some distance farther east, which receives no glacial melt-water. Just below 29 is a waterfall in a rocky gorge, and downstream the river touches solid rock at several points. Upstream from the fall to 32 the floor is gravel-covered and after 33 it rises steeply into the mountains. Both of these two rivers have their gravel-filled portions sloping much more steeply than the Spey but less so than the Kalfafellsdalur river. The two glacial streams have the steeper grades, but the Laxa is still very steep, apparently owing to the great abundance of debris brought down the precipitous mountain sides, whose unvegetated basalt slopes yield readily a vast quantity of waste.

The Offshore Bar.—More than 200 miles of the southern shores of Iceland consist of a great offshore bar. The mountains of the hinterland reach the shore at only two points—Portland, south of Myrdalsjökull, and the Vestur Horn. Elsewhere the great embankments of sand and shingle enclose wide areas of lagoon, marshland, and gravel flats. Numerous rock outcrops are incorporated in the embankment, frequently forming nodal points from which the beaches recede in sweeping curves both to the east and west. Breaches occur at intervals through which both land and tidal waters of the lagoons sweep with considerable velocity. The eastern section of this shore-line, if we exclude minor irregularities, follows a great concave curve from the rocky headland of Ingólfshöfði on the west to Vestur Horn on the east. This smooth run of shore deviates slightly where the great glacial tongue of Breiðamerkurjökull pushes out to sea, so that the shore eastwards from this point to the Vestur Horn forms a convenient unit for study.

The offshore bar was probably initiated by the fall in sea-level from the post-glacial 130-foot beach, which is well developed in this neighbourhood. The sea then came to rest on the gentle slopes of a great belt of outwash sands and gravels which covered the rock floor of an earlier marine-cut bench. The Atlantic storm waves threw up this material into a great offshore bar far to the seaward of the normal low-water mark. The bank is, for the most part, a simple one showing no aggradation ridges, and appeared as if, in recent years at least, it has been slowly driven back by the usual process of debris being thrown back over the top of the bank by the larger storm waves (18) Only at the entrance to Hornafjörður were small aggradation ridges observed.

The texture of the beach varies for the most part between a fine gravel and a coarse sand, but occasionally this is replaced by shingle. Where finer material predominates the slope of the foreshore is both more gradual and more uniform than with shingle, and the top of the ridge is seldom more than 12 to 15 feet above mean sea-level, the tidal range at springs being 12 feet. The effect of large waves is to sweep over the top of these banks and to wash the material great distances inland, forming a gentle back slope into the lagoon and giving a total width frequently exceeding half a mile at mean sea-level.

The great difference between the profiles of a sandy and of a shingle beach needs a word of explanation. Elie de Beaumont (19) seems to have been one of the first authorities who noted the tendency of waves to form a slope of sand or shingle adjusted to their action, and he was followed by Gilbert (20). Vaughan Cornish (21) discussed the action in detail and stressed the part played by percolation. Johnson (22) later considered friction and percolation together, but it remained for Owens and Case (23) to add to the above, the effect produced by the backwash gaining velocity in accordance with the formula $v^2=2gh$, where v=the velocity at h units below the starting point and g=gravity.

The circumstances leading to the building of a shingle ridge have been discussed by the writer more fully elsewhere (24). The swash, or uprush of water from the breaker, always tends to drive the shingle up the beach and the backwash, which has lost much energy by friction and percolation, tends to return it. As the backwash succeeds the swash it has the greater effect of the two in determining the beach profile. This latter follows a concave curve, very steep at the top and grading gradually down to the low-water mark, for the backwash starts from rest at the top of the beach and at first can only move material if the slope is steep. The returning waters gain velocity in accordance with the formula $v^2=2gh$, neglecting friction, and become capable of moving the material over a flatter slope. Hence the shingle driven up the beach by the swash is combed down to a sweeping concave curve by the returning backwash. The profile, steepening to the top of the beach, deflects upwards the swash of storm waves, and hence they pile up the shingle to greater and greater heights, limited only by the supply of material and the size of the waves. Eventually the ridge attains such proportions that even the most powerful waves in conjunction with the highest spring tides can barely overtop the bank.

With the smoother surface of a sandy beach the waves do not seem able to get such a bite on the material and drive such a load to the top of the beach. Also the backwash can return the fine material down a very gradual slope, and hence the beach profile does not become very steep. Thus, when storm waves break on the shore they find no great rampart to deflect their energy upwards, but sweep over the top of the beach carrying large quantities of sand into the lagoon behind, thus widening the bank. Much of the swash of these waves never returns down the foreshore, and so there is only a very slight tendency for the concave curve to develop, whereas the profile is often slightly convex at the top as a result of the storm waves sweeping over the embankment.

Owing apparently to the relatively high proportion of fine material, the Icelandic storm beach is characterized by its great width. At one point

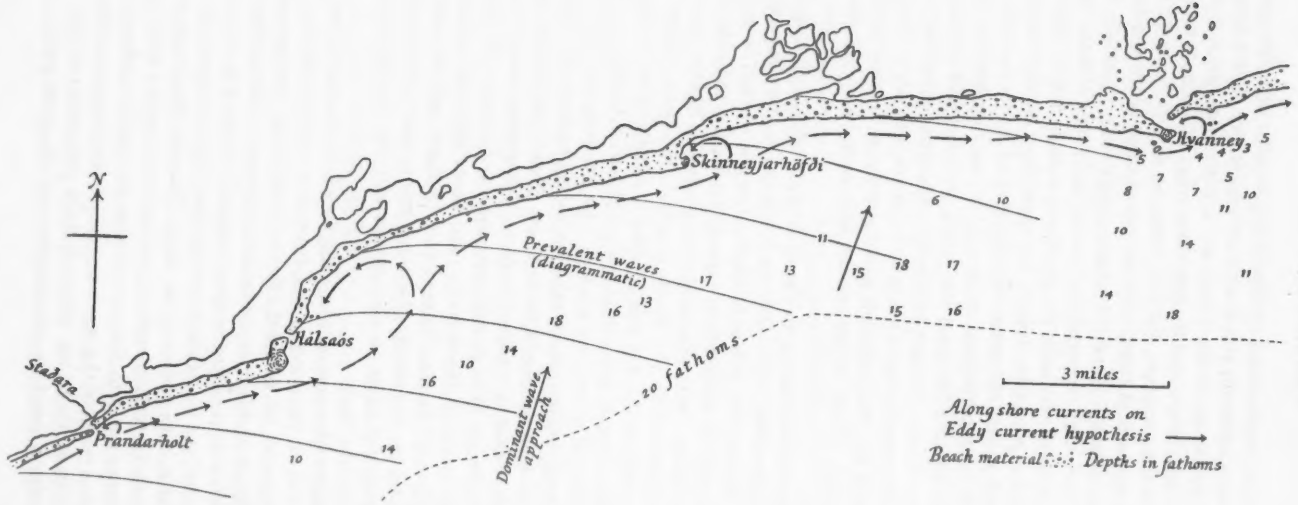

N
Skinneyjarhöfði
Hvanney
Prevalent waves
(diagrammatic)
Hálsaós
Stöðvarfjörður
Prandarholt
Dominant wave approach
20 fathoms
3 miles
Along shore currents on
Eddy current hypothesis
Beach material
Depths in fathoms

Fig. 8

however there exists what must be one of the greatest shingle embankments in the world.

Immediately to the west of Ingólfshöfði, an exposed rocky headland due south of Örœfajökull, the ridge rises from a height of 13 feet to 120 feet [1] above mean sea-level in little over half a mile. At this height, three times that of the Chesil Beach at its highest (25), it approaches very near to that of the adjoining headland. In view of the unprecedented size of this embankment it is necessary to stress that no alternative explanation seems feasible. In plan, profile, location, and general appearance it conforms to a normal shingle bank, the only difference being one of magnitude. Also the steepness of the seaward slope is in itself a proof of its recent origin. The height cannot have been increased by any addition of scree material from the neighbouring headland, as the bank maintains a nearly level crest for some distance from the headland itself. Further, it can hardly be attributed to a higher stand of the sea, because all remnants of the 130-foot raised beach occur at the base of the cliffs many miles inland. When the sea stood at this higher level Ingólfshöfði must have been a rocky islet more than 5 miles offshore, deprived of any considerable source of shingle supply as the neighbouring outwash gravel plains were covered by some 100 feet of water. To-day the prevalent south-west waves drift material from west to east, much of which is held up by the headland, thus affording an almost unlimited source of supply. Whether the sudden increase in the height of the bank is due to the holding up of the drift or to an increase in the coarseness of the material, we were unable to ascertain. A severe storm prevented our boat from approaching sufficiently close to the shore for us to observe the nature of the beach material.

Fig. 8

The height to which the swash of storm waves reaches after breaking on the shore is dependent on (*a*) the size of the waves as they approach the shore and (*b*) the energy which they lose between their first encounter with the shelving sea-floor and the moment of breaking on the beach. Powerful waves offshore are favoured both by the great stretch of open water available and by the exceptional velocity of the storm winds associated with the North Atlantic cyclonic disturbances. The length of open water is far in excess of that required for the development of maximum wave size (26). The loss of energy on approaching a shore-line is a function of the amount of shallow water both directly offshore and for some distance alongshore in either direction. For the presence of shallow water in the vicinity produces a curving of the wave-fronts as they approach the shore and a consequent distribution of wave energy over a wider front (27).

In both of these respects the section of shore under discussion causes a minimum dissipation of wave energy, for the 20-fathom line lies only a mile offshore and the embankment is at the leeward end of a straight run of shore and almost flush with the most exposed headland on the south coast. It seems therefore that all the above factors have combined to produce by far the greatest shingle embankment on record.

The trend of the beach.—The storm beach as a whole sweeps round in a nearly concave curve from the headland of Ingólfshöfði to the Vestur Horn.

[1] The Danish Geodetic Institute give the height as 37 metres above mean sea-level.

When followed in detail however the individual sections are seen to be asymmetrical, with the longest reaches consistently facing south or south-south-east. This feature is very well shown in the shore running east from the Staðara (Fig. 8). A straight run of shore ends at the headland formed by the rock outcrops at Þrándarholt. Immediately to the east the beach becomes much reduced in size and runs north for a short distance and is breached by the outlet of the Staðara. It then turns north-east again, passes a minor salient apparently induced by a rock outcrop and follows a straight course for 3 miles terminating at a second headland formed by a large rock exposure. East of this headland the beach once more recedes to the north, is again breached by the lagoon outlet of Hálsaós, and after running north-north-east for $1^1/_2$ miles, once more turns to the dominant east-north-easterly direction in which it continues for over 6 miles to join a third headland, Skinneyjarhöfði, again located at a rock outcrop. A similar relationship holds in the 9-mile stretch of coast which leads to Hornafjörður entrance, but in this case the beach turns to face due south and the last 2 miles face slightly west of south. The beach is more massive, with a few minor exceptions, along the straight sections than the shorter curved ones. The eastern end of each run of shore is built as far to the south as possible, whereas the westernmost sections are invariably set well back to the north of the adjoining headlands. The beaches therefore do not follow symmetrical curves from headland to headland; this simple arrangement is replaced by a tendency for the major sections to face a southerly direction. This tendency is in no way related to the mainland behind or to the offshore contours. The most important factor would seem to be the direction of approach of both the great storm waves which have thrown up the embankments and the prevalent waves which are responsible for the drift of material. These waves reach this part of the Iceland coast from the south-south-west (28). In earlier papers by the writer in this *Journal* (29) it has been suggested that, when due allowance is made for the influence of bounding headlands and offshore contours, there remains a residue of direction-determining force which can be attributed largely to the direction of the dominant waves (30). On the coast-line under discussion the major directional controls are the lie of the rocky headlands and the general run of the offshore contours. One would expect these alone to give rise to a shore swinging symmetrically from headland to headland. The influence of wave approach seems to show itself in the marked asymmetry of the curves. This feature is repeated so systematically along the whole run of the coast that the sole common factor of wave approach would seem to be the responsible one.

The dominance of southerly and south-westerly waves over those from a more easterly quarter is due partly to the greater strength and duration of winds from these directions in the North Atlantic and partly to the greater stretch of open water. Cornish (31) found the minimum stretch of open water necessary for the full development of storm waves in the North Atlantic to be from 700 to 1000 miles, which is slightly in excess of the length of open water to the south-east or east from this coast, but is readily available to the south or south-west. Once the south-facing sections have exceeded in length those facing south-east this very fact further increases the wave size in the

former case because less energy is lost through the curving of the wave-fronts (32).

Finally, the relation between the shore direction and the line of approach of the prevalent waves also tends to make the southerly facing sections more massive and therefore more stable. The prevalent waves come from a south-westerly quarter and are therefore inclined to the south-east facing sections at a greater angle than to those facing south. Hence the speed of drift is accelerated immediately to the lee of the headlands and retarded along the main south-facing shores. This retardation must lead to a concentration and the acceleration to a thinning of the material on the foreshores affected. Consequently the south-facing sections are continually strengthened at the expense of those facing south-east. The starving of the latter shores is further evidenced by the fact that all the breaks in the beach within the region under discussion occur in these sections. The rocky headlands also probably act as groynes and partly hold up the drift of material on their western sides so that the embankment lies flush with the headlands on this side. Thus the major southerly facing sections of the shore seem to be due, in the first place, to the direction of the dominant storm waves, and once built they tend to collect abundant material on their seaward slopes and thus to get built still larger. Several factors therefore combine to make them the dominant feature in the configuration of the offshore bar.

The second major physiographic fact is the coincidence between the lagoon outlets and the relatively short south-east facing sections of the shore, and this also seems to be due to the alignment of the shore with regard to both the dominant and prevalent waves. The hypothesis most frequently used to account for such a configuration is that which invokes the aid of alongshore and eddy currents (33). Such an explanation seems quite inadequate in this case because (*a*) most of the material is too coarse to be moved by current action alone; and (*b*) the drift does not approach the headlands from opposite directions as it would if longshore and eddy currents were the motivating forces (see Fig. 8). As far as the writer is aware no clear evidence has yet been produced of large-scale eddy currents modifying a shingle foreshore, in spite of the fact that they should be readily susceptible to observation. The only evidence in favour of such a hypothesis seems to be the occurrence in certain places of tidal eddy currents some distance offshore (34). The ease with which hypothetical eddy currents can be drawn to follow the sweeping curves of a coast-line such as that indicated in Fig. 8 together with their constant appearance in hydrodynamics, nevertheless makes the theory a tempting one to adopt.

The Hornafjörður Entrance.—The arrangement of the beaches adjacent to the Hornafjörður entrance presents many points of interest and is of a more complex pattern than other sections of shore with a similar disposition (see Fig. 9). The gap in the beach is unusually wide, exceeding 400 yards as against 80 yards for the average width of the breaches farther west. The reason probably lies in the very large area of water in Hornafjörður and Skarðafjörður which gives rise to exceedingly swift flood and ebb currents through the lagoon entrance. The smaller gaps to the west hardly influence the general run of the beach on either side. The great waves responsible for

throwing up the beach must break across these outlets with their fronts almost undeflected, or more probably the greatest waves throw up a temporary bank right across the outlet, as occurred previous to 1905 with the Staðara.

The Hornafjörður entrance is clearly wide enough to modify very considerably the work of the waves on either side. The western beach joins the rocky headland of Hvanney in a somewhat attenuated form and overlaps the east arm by quarter of a mile. This latter is a simple gravel and shingle embankment right to the end. Its length seems to be limited by the swift tidal scour round the point. During ebb tide the waters of the lagoon can easily be seen to stand at a higher level than the open sea. The resulting gradient is a maximum immediately round the end of this eastern arm, and here it gives rise to a swift tidal race which actively scours away the finer material.

The outline of the seaward shore of this spit deserves brief mention. The

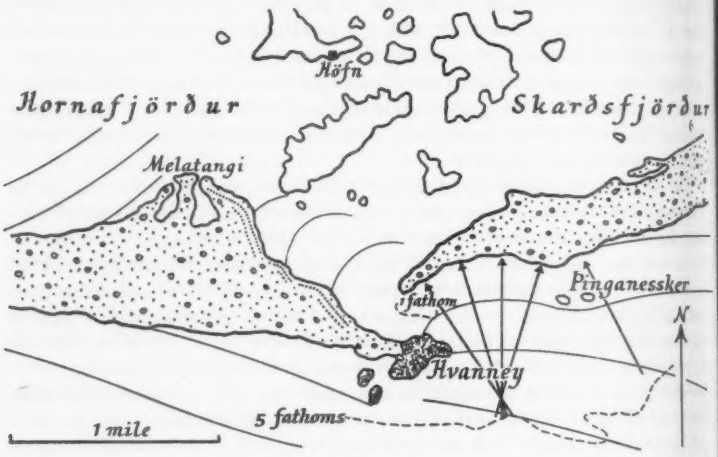


Fig. 9

last three-quarters of a mile of the beach follows a perfect arc of a circle, the centre of which stands at the junction of the radii drawn in Fig. 9. This arcuate form seems to result from the shelter afforded by the headland of Hvanney and the islands of Þinganessker. They modify the direction of approach of both the dominant storm waves which build the embankment and the prevalent waves which drift the material alongshore. The largest waves to reach any given point on the curve must pass roughly mid-way between the headland and the islands, as waves just skirting either feature are deflected somewhat and their energy correspondingly diffused over a wider front. Owing apparently to a general dominance of waves from a south-westerly and southerly quarter over those from the east and south-east, the focus of the lines of approach is moved to a position slightly west of central, that is, to a point near that indicated in the figure. Then, on the hypothesis outlined above, the embankment would tend to be aligned so as to lie at every

point parallel with the dominant wave fronts, that is, approximately along the arc of the circle centre O. The almost geometrical precision of this arc is presumably due to the high degree of protection afforded by the two rock masses; this probably nullifies the tendency to follow an asymmetrical curve, as demonstrated by the more exposed coast-line farther west. The rocks exclude waves from any direction of approach which departs much from those of the radii shown, so that the stretch of shore is relatively free from waves which would tend to disturb the arcuate form. Also the material is evidently present in sufficient quantities for the embankment to be independent of the run of the sea-floor.

The influence of the prevalent waves responsible for the drift of material must also be considered. Owing to the approximate coincidence between the direction of both dominant and prevalent waves in this region, the mean direction of wave approach to any part of the curved shore will also tend to follow the same radii. Thus, with the shore-line adjusted to follow the arc with centre O, the prevalent waves will be everywhere almost directly onshore, and will therefore cause little or no permanent alongshore drift. The arcuate form is thus seen to be a very stable one, as if for any reason the shore-line diverges temporarily from it, the resulting obliquity of wave approach initiates a drift of material always tending to smooth off irregularities and encourage a return to the arcuate form.

Thus the controls exerted by the rock outcrops bordering the fjord entrance on both the dominant and prevalent waves seem to combine to produce the arcuate pattern so perfectly developed.

The salient formed in the beach behind the islands of Þinganessker seems to be due to the protection it receives from southerly waves. It is the counterpart of the curved shore-line. The dominant and prevalent waves can approach the west side of the salient only from a south-south-westerly quarter and the east side only from a south-south-easterly quarter. Accordingly the ridges are thrown up in directions parallel to these two sets of waves and meet to form a well-marked salient. The important factor is the complete protection from southerly waves which would tend to drift material away from the salient and flatten the angle by throwing up south-facing ridges in line with the general run of the shore.

Inside the entrance on the western arm is a series of asymmetrical corrugations which culminate in the shingle spit of Melatangi. They again seem to represent the attempt of the beaches to adjust themselves to the direction of wave approach. Both the dominant and prevalent waves come through the fjord entrance from the east-south-east and strike this shore very obliquely. A series of small shingle ridges have been built oblique to the general run of the shore and more nearly following the direction of these wave fronts. Once such minor salients are formed they tend to be aggraded by the addition of further ridges on their seaward-facing sections. For the speed of drift is there retarded owing to the smaller obliquity of wave approach. This action is visible on most days, and it leaves an abundance of material on the stretches where the speed of the drift is reduced. Larger easterly waves, coming straight through the lagoon entrance, especially during high spring tides, then throw up this material into a ridge in front of the preceding one, eventually

producing the pattern indicated in the figure. There are four distinct salients visible on the map, the largest of which is recurved at its northern end to form the easternmost of the three spits of Melatangi. The smaller features provide simple examples of embryo cuspate forelands, and have been noted on many parts of the British coast-line (35).

The embankment forming the western end of the composite feature of Melatangi seems to have been built from shingle drifted eastwards by north-westerly waves generated in the waters of the lagoon. Larger waves during storms from this direction also seem to be responsible for the building of this ridge which exactly faces the greatest stretch of open water in the lagoon. Melatangi therefore seems to have formed at the point where two directions of drift converge and its outline to be related to the direction of the largest waves to which its different sections are exposed.

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THE ARCHAEOLOGICAL HISTORY OF LAKE OSTROVO IN WEST MACEDONIA

MARGARET HASLUCK

IN an earlier paper in this *Journal* (vol. 87, pp. 338–47), when discussing the erratic fluctuations of Lake Ostrovo in West Macedonia, I argued (pp. 346–7) that for some centuries before A.D. 1800 the fluctuations, if they occurred, were insignificant by comparison with those of modern times. First I observed that in a country where there is plenty of spare ground and the inhabitants are familiar with the geographical conditions, substantial buildings are not erected, nor are graves dug, on sites subject to repeated, frequent, and prolonged inundation. Then I noted that the Turks, who came to this part of the world in A.D. 1388, built some time afterwards on the island near Ostrovo village a handsome mosque, which seems to have survived till overtaken by the lake in the middle of the nineteenth century; and that they, who in general are extremely particular about the disposal of their dead and at Ostrovo had plenty of waste space, had, at least in the seventeenth century, buried people round this mosque. In other words, on a site wholly covered with water for several years by the great inundation of 1858–62, and partially so covered for a similar period by the lesser inundation of 1923, they had in earlier centuries erected a substantial building and dug graves. It is therefore most improbable that those earlier centuries had witnessed inundations of comparable magnitude.

There is further evidence to the same effect. No other meaning can be put on the failure of so eminent a traveller as Colonel W. Martin Leake to visit the lake in 1806,[1] when within a few miles of it and not pressed for time. In 1839 Grisebach was told [2] at Ostrovo village that, apart from the supposedly "temporary rise" which he witnessed,[3] the size of the lake had not altered within living memory. At the narrow south end of the lake, so I have been informed by M. Diamantopoulos of Novigrad, there is a submerged bridge which spanned the River Nalbanköi till comparatively recent times; portions of its timbers can still be seen *in situ* under the water. Above all, as I learned only in May 1936, by the lakeside at Pateli on the south-west shore of the lake there is an ancient Christian monastery with an important history. This monastery is dedicated to St. Panteleemon, the patron saint of the village, who enjoys so much local fame that on the eve of his festival on July 27 crowds come from neighbouring villages to hear mass in his church at dawn, the most propitious hour for religious services. For want of accommodation the pilgrims camp out for the night where they can, and the church is a small chapel comparing very ill in both size and equipment with the church on the hill above the village, and that though the latter is quite unimportant. The lack of provision for the pilgrims and the poverty of the chapel are both due

[1] Cited in my paper in the *Journal*, vol. 87, p. 345.

[2] 'Reise durch Rumelien,' ii, 153: "dass die Grösse des Sees sich seit Menschengedenken verändert habe, wurde entschieden verneint."

[3] *Ibid.*, ii, 152.

to the fact that it is patently a waste of money to erect good buildings near the chapel; the lake is so near that it submerged the site both in 1858–62 and in 1923. Until recently however this site was occupied by a large and opulent church which formed part of a monastery with an extensive garden, and the pilgrims were housed for the night in a big, rambling guest-house within the monastery precincts; this guest-house contained a room reserved, according to Balkan custom, for each village attending the festival, and each room was large enough to sleep thirty persons, Balkan fashion, on the floor. It is immediately clear that during the lifetime of these considerable buildings the lake remained lower than it has generally been in modern times. The duration of this low level is fairly easy to establish. There is a sound tradition at Pateli that the monastery was destroyed during the lake's rise to its maximum of 1858–62. For instance, the oldest priest in the village, who was born in 1862, has always understood that the church was overwhelmed shortly before his birth, and as a child he was often entertained by the widow of his father's brother, who had seen the guest-house intact, with descriptions of its magnificence. When destroyed, the monastery church, if not the guest-house, must have been several centuries old. Since it was not till the days of the reforming sultan Mahmud II (1808–39) that the Turks permitted their Christian subjects to build new churches,[1] it cannot have been built later than the Turkish conquest of West Macedonia in A.D. 1388.[2] Thus the lifetime of the monastery, and with it the duration of the low level of the lake, lay between the end of the fourteenth century and the middle of the nineteenth. In fact, we may push back the low level of the lake for at least fifty years more, for the monastery would hardly have been built so low down the hill if within living memory of the builders the water had ever risen high enough, as in modern times, to menace the site.

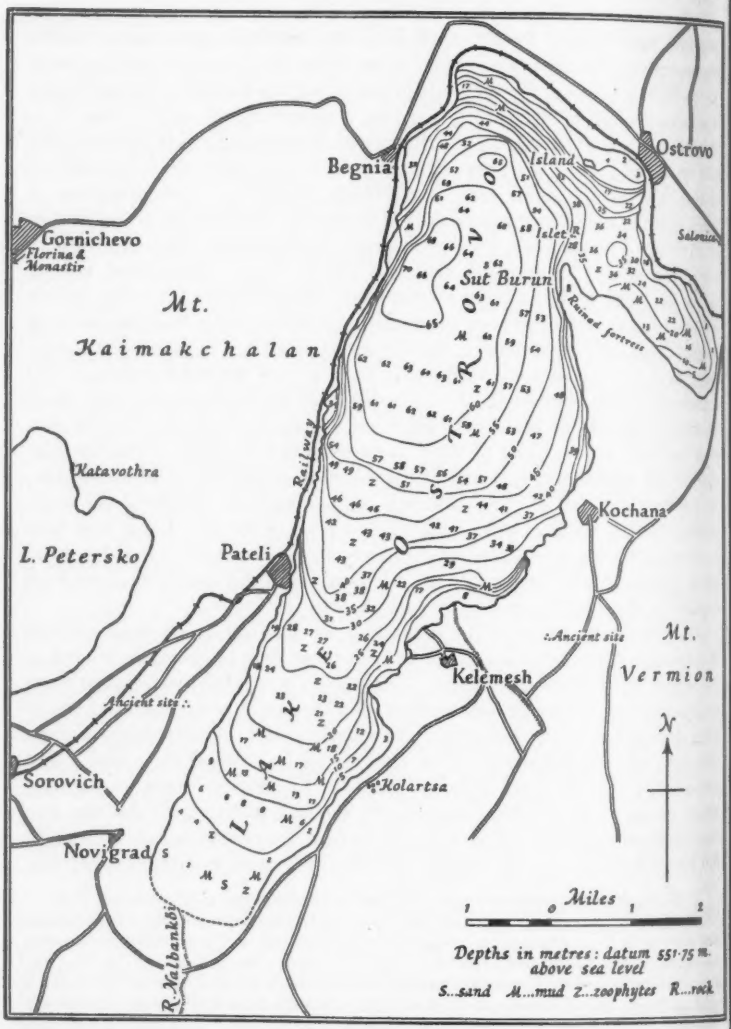
With the construction of the monastery we are back in Byzantine times. Our meagre information about the lake in those days is generally related to the island beside Ostrovo village. This island, it will be remembered from several passages in my previous paper, is a peninsula until the lake rises to more than 533 m. above sea-level.[3] Now Pachymeres, the thirteenth-century historian, describes the village of Ostrovo as an "island in a lake," and Cedrenus, in the eleventh century, knows it by its Slav name of Ostrovo, which means "island." So it is generally thought that in their day the lake stood high enough, at least on occasion, to turn the peninsula into an island.[4] But here a doubt arises. To which island do the Byzantine authors refer? For

[1] F. W. Hasluck, 'Christianity and Islam under the Sultans,' p. 382.

[2] The fourteenth century probably saw the foundation of the two chief monasteries now existing in West Macedonia, respectively Tsarouseno, at the northern entrance to the plateau of Anaselitza, and Zaborda, in the wild country east of Grevena. An inscription in the church of the former states that the frescoes in the church were not painted until A.D. 1493. But this means only that, by the time the church was built, funds were exhausted and the frescoes had to wait until more were available; such delay is common in the Balkans. Zaborda is said to have been founded by St. Nicanor at the end of the fourteenth century by special leave from the Turks in return for the help he gave them in conquering West Macedonia.

[3] This height is deducible from the evidence given in the first and second paragraphs on p. 342 of my previous paper.

[4] *Ibid.*, p. 347.



Lake Ostrovo

there are two. The larger is the one hitherto in question; the smaller, an islet [1] with a diameter of no more than 100 paces, lies between this island and Cape Sut Burun. Nowadays the islet remains buried under water till the lake-level sinks to less than 529 m. above the sea; this we know from Oestreich,[2] who says that in August 1899, when the lake was 526·18 m. above sea-level,[3] the top of the islet was about 3·4 m. above the water. So after the lake has sunk to 533 m. above sea-level, the height at which the island near Ostrovo becomes a peninsula, it must sink 4 m. more before the islet near Sut Burun is bared. Since the islet is so slow to appear, it has not been seen for the last thirty years, and before its disappearance it had been visible for only twelve years.[4] But there is no telling that it was not permanently above water in Byzantine times. For at a still earlier date it was inhabited. The peasants of Ostrovo say it was the original site of their village,[5] and within the narrow limits of their experience peasants are always better at geography than chronology. More significantly, on the south side of the islet there are substantial remains of walls, its whole surface is littered with building stones and pottery fragments, and part of it was once used as a burial ground. Struck,[6] on excavating the graves, found not only a tombstone of Roman date with a Latin inscription,[7] but also bronze funeral objects which he tentatively assigned to the sixth or seventh century of the Christian era. Since we thus know for certain that the islet was inhabited in late Roman times, we are precluded from saying without further evidence that it was not permanently above water in the Byzantine period. Then two alternatives for that period are before us. If the islet was sometimes under water and sometimes above it, as nowadays, the island near Ostrovo was most probably sometimes an island and sometimes a peninsula; in that case the Byzantine authors referred to the island, and the lake attained its modern levels. On the other hand, if the islet was permanently above water, the island near Ostrovo remained a peninsula, the Byzantines referred to the islet, and the lake was consistently lower than in modern times.

On the whole the balance inclines very slightly in favour of the latter alternative. It is something that the construction of the monastery at Pateli, with the low lake-level which it implies, was not more than a century after the *floreat* of the historian Pachymeres. In the second place, important deductions may be drawn from the ruined fortress on Sut Burun. Few fortresses can be more curiously situated. The walls descend the steep sides of the cape to the water's edge—the northern wall is indeed submerged when the lake is 535 m. or more above sea-level—and above the walls, and on either hand, there is nothing but the forlorn and barren hillside; not even a goat-track leads to or from the site. The peasants, struck by the apparent purposelessness of the building, explain its existence by a story common in folklore.

[1] Karl Oestreich, "Beiträge zur Geomorphologie von Makedonien," in *Abh. d. Geogr. Ges. Wien*, vol. iv, 1902, p. 147; Adolf Struck, "Die Makedonischen Seen," in *Globus*, vol. lxxxiii, No. 14, 1903, p. 217.

[2] *Loc. cit.*

[3] Carl Kassner, "Die Seespiegelschwankungen des Ostrowsees in Makedonien," in *Gerlands Beiträge zur Geophysik*, XXXV, Heft 3/4, 1932, p. 364.

[4] Struck, *loc. cit.*

[5] *Ibid.* The story is still current at Ostrovo.

[6] *Loc. cit.*

[7] Published by N. G. Pappadaki in *Ἀθηνᾶ*, xxv (1913), pp. 434–5, No. 16.

It was built, they aver, by a king who tried to save his only daughter from the early death foretold for her by marooning her in this inaccessible spot. But a serpent wriggled its way into the fortress, bit her, and so fulfilled the prophecy.[1] More rationalistically, we argue that never was fortress built without a road to command or to enter by; that the only road possible at Sut Burun, the lie of the land being as it is, must have come from the east and rounded the cape to run southwards between the base of the mountain and the water's edge; that since no trace of any highway can be discerned, the road must now be wholly under water; and that since the ground falls very steeply both above and below water,[2] the road, if of any width at all, must have lain many metres below the present surface of the lake. Briefly put, the existence of the fortress presupposes the existence of a road and, consequently, the maintenance of a very low lake-level. So far the bearing of the evidence seems indisputable. But the date of the fortress, and all that that date means, is difficult to ascertain. The walls are now almost level with the ground and indistinctive. Some years ago a peasant, dreaming that there was treasure buried outside the eastern wall, enlisted the help of his friends to disinter it. Three times he dreamed this dream, and three times they responded as he wished, but the only treasure they found was archaeological. This consisted of the foundations of a tower and a portion of the adjacent wall. Both had been built with mortar, but no potsherds having been found near them, it is impossible to determine their date. There are indeed very few fragments of pottery within the whole enceinte, but this is only natural on a fortress site, for pottery fragments are never found in quantity except on closely inhabited sites. The large numbers outside the short northern wall, which abuts on the water, have probably been washed up from near the islet; those identifiable seem of Roman date. Two fragments of ancient roof-tiles which I found in 1935 were each 15 inches broad; their length and their date I could not determine. Thus we cannot say from the archaeological evidence whether or not the fortress dates back to Roman days. But we may conjecture that it remained in active occupation down to Byzantine times. For its destruction has been remarkably uniform. On all four sides the top of the wall is practically a straight line, and all the stones dislodged have fallen outside the walls, peculiarities which suggest that its destruction was deliberate and man-made. For the remains of buildings ruined by fire, earthquake, or natural decay are characterized above all by irregularity, some portions being high and others low, some stones lying inside the walls and some outside. So this fortress may have been one of the Bulgarian strongholds round Ostrovo destroyed by Basil the Bulgar-slayer after he had routed the Bulgarian king Samuel in A.D. 1014,[3] *i.e.* in the middle

[1] M. Stavros Hatziharisi of Ostrovo informs me that this legend arose because the Roman relief found by Struck on the islet represented a serpent trying to bite a child which was being suckled by its mother; the relief was taken secretly to Russia. Unable to check this story, I give it only for what it may be worth.

[2] *Cf.* A. Viquesnel, in *Mémoires de la Soc. Géolog. de France*, 2nd series, vol. I, pt. ii, 1846, p. 252, for a general description of this shore of the lake; this holds good in spite of the confusion in the nomenclature, for which see my paper in the *Journal*, vol. 87, p. 344, n. 6.

[3] S. Runciman, 'First Bulgarian Empire,' p. 247, basing on Migne's Latin translation of Cedrenus, *Compendium*, II, 465.

of the Byzantine era. If so, it is arguable that the Greek king would not have troubled to destroy it if the lake had been high enough to leave it as it is to-day, derelict and without a road to guard. In other words, the probability that the fortress was destroyed in the Byzantine period increases the possibility that in that period the lake was very much lower than to-day.

We now turn to late Roman times. As we have seen above, there are graves of that date on the islet near Sut Burun. These tell us convincingly, according to the canon given on the first page of this paper, that in their time the lake remained many metres below its lowest modern level. Their evidence is supported by other ancient remains in the neighbourhood. To put on one side the foundations of the fortress on Sut Burun, there is an enormous block of limestone [1] at the comparatively flat south-east corner of the island near Ostrovo village; since it measures 1·75 m. long, 0·61 m. broad, and 0·51 m. thick,[2] it is too big to move easily, and so may be presumed to lie in its original position. A Greek inscription states that it is a funeral stele set up by "Markeliane to her sweetest husband . . . . Alexander." As the letters, notably the *sigma* and the *omega*, are of the same type as those on a dated inscription [3] from Edessa (Vodena), its date seems to be about A.D. 240. It was only just clear of the water at my visit in October 1934, when the lake stood 533·73 m. above sea-level,[4] and at the moment of writing it is completely under water. Then again, when the lake recedes to less than 535 m. above sea-level, ancient tiles and pottery fragments can be seen on the beach at the north-east corner of the lake. They are so numerous that they can only come from a considerable village, if not a small town, which is now submerged. On the same beach, according to M. Stavros Hatziharisi of Ostrovo village, the foundations of a large building can be seen when the lake sinks to 532 m. or less above sea-level. This building is said to have been a monastery, but not convincingly; it is a common assumption among Christian peasants in the Balkans that extensive ruins adjacent to their village, if obviously no part of a castle, belonged to an ancient monastery. On the island near Ostrovo village, especially on the long south side, foundation walls are to be seen.[5] The peasants say they belong to the houses of "those years," *i.e.* long ago. But their character, where they are best preserved, and their length make me prefer to think them part of an old castle,[6] perhaps another of the Bulgarian strongholds round Ostrovo destroyed by Basil the Bulgar-slayer.

In the later centuries of the pre-Christian era, so the evidence would seem at first to show, the lake was again much lower than it is to-day. At the eastern end of the base of Mount Kaimakchalan, near the 140th kilometre on the railway,[7] and so 3 km. west of the village of Ostrovo, there are ancient ruins

[1] J. H. Mordtmann, in *Athenische Mittheilungen*, xviii (1893), p. 418; Asima, in *Bulletin de Correspondance Hellénique*, xvii (1893), p. 634.

[2] My measurements; Asima's are different.

[3] Published by Mordtmann, *loc. cit.*, p. 516.

[4] As I have courteously been informed by M. Kyriakides, chief engineer on the Salonica–Monastir railway.

[5] *Cf.* Kassner, *loc. cit.*, p. 360; C. von der Goltz, 'Ausflug nach Macedonien,' p. 89.

[6] *Cf.* von der Goltz, *op. cit.*, p. 90.

[7] Struck, *loc. cit.*, p. 240.

at the hamlet marked Begnia or Bendje on modern maps. Like the fortress on Sut Burun, these ruins stand at the water's edge, with little or no tillable land near them, and the adjacent village is a miserable collection of poverty-stricken huts. The Frenchmen who excavated these ruins during the European War identified them as the stables of the Macedonian kings,[1] so placing them in the fifth to second centuries B.C.; since horses need room for grazing and exercising and at the present level of the lake no such room is available at Begnia, the identification postulates a much lower level for the lake in the centuries concerned. Unfortunately the identification is difficult to accept. The Frenchmen in question were as much soldiers as archaeologists, and their minds were stirred by fighting in the very country which had bred Alexander the Great. Their evidence was never published in detail, and is no longer available.[2] Why ruined stables should survive when all other buildings, important and unimportant, have perished, is not clear. For these reasons it seems safer to discard romanticism and to say that the ruins are probably not contemporary with the Macedonian kings, but late Roman, like the tombstone published already in 1913.[3] So they tell us little that is new—only that in Roman times the lake, being low for several centuries as we have already been told by the islet and adjacent remains, had left Begnia enough cultivable land to make it of greater importance than it is to-day. For conditions under the Macedonian kings we have no information.

The varied evidence from Roman times which we possess enables us to suggest a more satisfactory site for Bokeria, the ancient town which gave the lake its Latin name of Begorrites.[4] On modern Greek maps Bokeria is identified with the village of Novigrad at the south-west end of the lake, where there are clear traces of ancient settlement.[5] But there is a fatal flaw in this identification. Our starting-point is an ancient milestone[6] found buried 2 m. deep in the ground at km. 170·450 on the railway, *i.e.* half a kilometre south of the railway station of Tserovo in the wild defile called Kirli Dervan. The stone is inscribed in Greek with the words "Bokeria 100 stades" (=18·300 km.),[7] and so Novigrad, which is only 12 km. by road from km. 170·450, cannot be on the site of Bokeria. The same objection applies to Pateli on the south-west shore of the lake, where again there must have been a considerable settlement in ancient times.[8] Only two sites, Chaljilar near the south end of the lake and Kelemesh on its eastern shore, are the correct distance from km. 170·450. Chaljilar may be at once ruled out. Even during the exceedingly high water of 1862,[9] when the lake must have spread far across the plain at its southern end,[10] this village was a good mile from the water's edge.[11] So in ancient times, when the lake was very low and therefore

[1] Ch. Picard, in *Annual of British School at Athens*, xxiii (1918–19), p. 7.
[2] So Professor Picard informs me by letter.
[3] Pappadaki, *loc. cit.*, p. 435, No. 18.
[4] Livy XLII, 53.
[5] See map, p. 450.
[6] Published by Mordtmann, *loc. cit.*
[7] *Ἐγ Βοκερίας σταδίοι ἑκατόν.*
[8] See below, p. 456.
[9] See my paper in the *Journal*, vol. 87, pp. 340–1.
[10] *Ibid.*, p. 339.
[11] H. Barth, 'Reise im Herbst 1862,' p. 158.

small, it must have been much too distant to give the village its name. On the other hand, Kelemesh, or rather the enclave between this village and Kochana, its northern neighbour, suits all requirements. Here many fragments of ancient bricks and pottery, many coins and bronze objects, have been found, and popular tradition states that the low hill in the background was once occupied by an ancient town.[1] As for its all-important distance from km. 170·450, we obtain that by returning for a moment to the ancient settlement on the islet near Sut Burun. Since, according to Oestreich, the top of the islet is 529·58 m. above sea-level, this settlement can hardly have existed after the lake had risen, say, to 519 m. above sea-level—it can hardly be doubted, of course, that the lake lay a good deal lower. But let us take this maximum figure. With the water at that height so large an area at the flat south end would be dry land that it would be possible to walk straight from Kelemesh to Novigrad, and thence to km. 170·450; this is clear from the map of the lake[2] made by Greek naval officers in the summer of 1931 when the average height of the water was 538 m. above sea-level.[3] Across dry land the total distance from Kelemesh to km. 170·450 would be roughly 18 km., *i.e.* the distance specified on the milestone. Struck also seems to have come near to placing Bokeria at Kelemesh, but unluckily calculated his distances from Ekshi Su, where he saw the stone; he forgot that it had not been found in that town, but was only transported[4] there for safe keeping by its German discoverers, the engineers who were building the railway, among them the distinguished Herr v. Meissner. The supposed road would have provided a useful alternative in winter to the mountainous stretch of the Via Egnatia which led northwards from Ostrovo *via* Gornichevo[5] to Monastir; travelling north on the one hand from km. 170·450, it would have soon joined the main highway near the modern Banitsa, and on the other hand travelling along the lakeside from Kelemesh-Bokeria to Sut Burun and then striking east, it would have again joined the main highway near Ostrovo village. The reasons for the destruction of Kelemesh-Bokeria are not hard to discern. All its importance and prosperity came from its command of the road by the lakeside. When that road was overwhelmed by the lake, it was crushed like the fortress on Sut Burun between the water and the barren foothills of Mount Vermion, and so left with no means of livelihood but fishing and goat-tending and with no alternative but to dwindle to the status of a village such as the modern Kelemesh and Kochana.

From prehistoric times there is good evidence—again from a cemetery—that the lake-level was very low. This cemetery, large but quite unknown except for a brief mention by Pappadaki,[6] lies a short distance east of Ostrovo village and contains cist graves of well-known prehistoric type. Part of it now looks like a disused quarry, for the French, when rebuilding the railway

[1] Struck, *loc. cit.*, p. 238.

[2] Here slightly modified. I am much obliged to M. Gardikas, Curator of the Geological Museum, Salonica, for allowing me to photograph this map.

[3] My information from M. Kyriakides, chief engineer on the Salonica–Monastir railway.

[4] Mordtmann, *loc. cit.*

[5] Picard, *loc. cit.*; A. D. Keramopoulos, '*Ἄνω Μακεδονία*,' p. 95.

[6] *Loc. cit.*, p. 435, No. 16.

line in 1916, dug deep into it for gravel. They found in the graves a number of prehistoric earthenware pots, such as any traveller can still see sticking out of the sides of the pit. These graves were inundated in 1923, and therefore in 1858–62. Since again there was plenty of ground available on higher sites, we can only think that in prehistoric times, *i.e.* in the eighth to sixth centuries B.C., when these graves were dug, the lake cannot have been high enough to be a menace.

I conclude this archaeological history of Lake Ostrovo with a brief mention of the ancient remains at Novigrad and Pateli. I have seen a late relief with a Greek inscription and some late coins and prehistoric bronzes, all found on top of the cliff above Novigrad; the relief was in the village, and the other objects in the hands of an employee of the lignite mine at Novigrad. The prehistoric site is said to be covered with the remains of houses destroyed by fire; if so, it might repay excavation. As for Pateli, the prehistoric objects found close by in 1899 by Russian archaeologists, but unhappily never fully published, are well known.[1] The modern village stands over another extensive cemetery containing both Roman and prehistoric interments: several funeral reliefs of Roman date are flush with the ground, and only in April of this year Professor Kotzias of Salonica University[2] excavated several prehistoric graves; his most striking finds, now housed in the archaeological museum at Salonica, are a series of beautiful beakers. The peasants of Pateli state that other graves are now under water; as at Kelemesh and Kochana, the ground at Pateli falls very steeply both above and below water. With the exception of these last graves, the remains at Novigrad and Pateli are too high-lying to tell us anything about the lake-level at the time when the sites were inhabited. Their interest for us is that they, together with the ruins at Begnia, Ostrovo, Sut Burun, and Kelemesh, confirm the local tradition that the ground now covered with water was once fruitful with "cities" and tilled fields.[3]

[1] Elevtherodakis, '*Ἑλλάς*,' p. 609; Meyer's 'Reisebuch von Türkei,' ed. 1908, p. 375; S. Casson, 'Macedonia,' p. 150 and Fig. 63.

[2] I am much obliged to Professor Kotzias and M. Gardikas of Salonica as well as Professor Keramopoulos of Athens for their helpful discussions of the subject-matter of this paper.

[3] See *Journal*, vol. 87, p. 345.

DANCE OF THE BASSAS AT ABAJI

DAPHNE K. KENNETT

Some time ago the Society acquired a series of water-colour drawings by Mrs. Kennett which were shown for several months in the Exhibition Room. Later we have received from her a series of notes upon the drawings, and have now the pleasure of reproducing, unfortunately only in black and white, some of the drawings with relevant notes. The whole series will be found in the Map Room collections.—Ed. G.J.

THE Bassas are agriculturists and their methods of cultivation have never varied. They dislike any suggestion of innovation, or of modern labour-saving contrivances. They have no knowledge of the rotation of crops, and where they have once grown yams, there will they continue to grow yams, and the same conservatism is applied to their crops of guinea-corn, cassava, groundnuts, etc. They will hack down trees ruthlessly in order to supply themselves with supports of the right height up which to train the bright leafage of the yams, and a plantation often presents the appearance of a forest of gaily festooned maypoles. Their one implement is a gigantic hoe; this has a splayed-out blade which is set at an acute angle to the wooden handle.

When visiting Abaji, a district in the north of the Koton Karifi Division of Kabba Province, we were fortunate enough to witness a Bassa harvest dance. Our coming coincided with their New Year, at which time they keep their harvest festival. The local chief, a man named Okuru, an Igala, arranged that we should also see Guari, Igala, Igbirra, and Gana-gana entertainments, and there was much similarity. The shuffling dancing steps and the monotony of the drumming and the forced humour of the antics of "dodos" were not interesting. One "dodo," a man disguised as a female, with sham breasts of attempted anatomical realism, was frankly revolting. After a short while the "dodos" turned a few half-hearted somersaults and cartwheels, and lost themselves among the crowd of spectators, who were duly kept back from the wide open space in front of Abaji resthouse by Okuru's police. There came a wild jangle of bells, and the weirdest objects came charging up the centre "drive." Fortunately I had been warned that the Bassa greeting might be alarming, but even so was scarcely prepared for what happened. There seemed to be a babel of noise, the crowd shouted and chattered, the drums beat, and about forty Bassas, their bodies and faces whitewashed, their heads adorned by horns and other strange head-gear, rushed towards us. Pausing to give forth loud coughing noises, something between forced groans and grunts, each man calculated the distance nicely and swung the great hoe he carried within an inch of our noses. It was difficult not to flinch, and to appreciate such an alarming greeting. Some of the men were nearly naked, but others in honour of the festival had arrayed themselves in a multitude of gaily coloured garments; some wore purple, plum-colour, apple green or scarlet pantaloons; some had short "jackets" and skirts, and most wore grassy aprons behind. Many of the headdresses were shaped not unlike Roman helmets, a semi-circle from back to front, but set with cowries and bits of looking-glass in symmetrical design; many strings of cowries hung from the edge of the semi-circle to the wearers' feet. I do not know upon what animal grew the gigantic

horns which decorated the heads of about a dozen dancers. It is a mystery how such large and heavy horns could be made to retain their position. They were set in huge "head-bags" of what appeared to be plaster of paris, and as they were fixed to protrude at extraordinary angles the effect was most terrifying. One man had impaled a realistic bit of scarlet rag upon the tip of one horn, and this stuck out forwards from the middle of his head. These overwhelming headdresses gave the impression that the Bassas are tall men, but they are of moderate height. Among the dancers was a little old wrinkled man with a red-and-green dyed beard; he wore sham spectacles outlined in scarlet beads, fringed with green and yellow wool, and from which hung strings of cowries all over his face. He proved to be the best dancer and his back-apron of cleverer design and cut than any. I have been unable to hear of any other native dance the main effect of which is determined by being viewed from behind, and which is deliberately danced in the direction away from the principal audience.

The dance begins by four men lining up, turning their backs upon you, and starting off down the centre approach with a hop and a skip. These men are followed at once by four more, and these by another four, until at last all the dancers are absorbed into a massed motion proceeding in strict time away from you. After the first hop and skip they break into a difficult movement which must be seen to be believed, so impossible of execution would it appear to be. The head, shoulders, and upper part of the body have to be kept rigid, so that the long strings of the cowries hanging from the headdresses do not sway with the back-aprons; but these must swing violently: to achieve this each man's body twists sharply from the waist downwards from side to side. His spine has also to curve forward from below the waist in order to give the aprons not only a sideways twist but a circular swirl as well. He brings his knee up to his chin and hops three times very quickly upon the heel of the other foot (the heel, not the ball of the foot); then the other knee is raised to the chin and he hops three times upon the other heel. Each dancer's arms are stretched out taut, his fingers just touching his neighbour's, and so forward they go in strict perfect time away from you until they reach the end of the dancing-ground, when they return, line up in their fours, start with the hop and skip, and dance away from you all over again. They continue to repeat this until they are dripping with sweat and are utterly exhausted.

Upon at least three subsequent occasions when by our request Bassas have danced their special dance for us, we have noticed that though the Abaji men were by far the most accomplished dancers, the dance itself was undoubtedly the same; the three hops upon the heel were performed with unvarying intention but with widely differing degrees of proficiency. Uniformity of effect was always produced by the exact synchronisation in the raising of the knees, the sideways swing of the back-apron, and the sharp spinal twist. The grasses of which the aprons were composed made a swishing sound, almost a tinkle, and any strings of cowries worn from the waist produced a rattling sound as well. Most of the dancers carried one or more brass bells slung to their girdles. We tried to buy, unsuccessfully, and then to order, also unsuccessfully, some Bassa bells for ourselves, but we found they were either personal or family property and never came into the market; neither could we discover details of origin or manufacture.

Bassa Festival Headdresses

Bassa festival dancers, Abaji

THE HADHRAMAUT

THE SOUTHERN GATES OF ARABIA: A Journey in the Hadhramaut. By FREYA STARK. *London: John Murray*, 1936. 9½×6 *inches;* xii+328 *pages; illustrations and maps.* 16*s*

IF all had gone well Miss Stark's journey in the Hadhramaut was really to begin from Shibam, but illness destroyed her hopes as she reached her starting point. She covered about 230 miles: 120 by donkey and the rest by car. Almost every mile of this had been described by previous travellers, and the towns in which she spent most of her time are to-day well known to Political Officers and the Royal Air Force. Be that as it may, Miss Stark's calibre and attractions as a writer have enabled her to make the 280 pages of her narrative not only vastly interesting but valuable to the student of Arabia.

Perhaps the principal point of historical and geographical interest was her rediscovery of the little village of 'Andal, which was missed by her predecessors, Van der Meulen and Von Wissman, on their journey to Huraidha. Miss Stark well deserved the thrill she must have had in finding this once famous place, for it is obvious that she had spared no pains to familiarize herself with the historical geography of the country before she ever set foot in it. Furthermore, her knowledge of Arabic enables the reader to be sure that when she is reporting conversations or information given her, she is reporting accurately.

Miss Stark has a very delightful way of seeing beauty and describing it in objects, such as the *jōl* and the *sumr* tree, which others might pass by as dull or dismiss as ordinary. Other qualities in the author which are impressed on the reader of this book are her courage and her patience. Security is maintained by the Qu'aiti Government on the routes she passed: had it been otherwise she would not have been perturbed, for her courage was put to a severer test by the illness that dogged her from Du'an till, more dead than alive, she had to be carried away from Shibam. How many would have cheerfully endured the old woman who spat on her as a treatment for measles? And yet in all her illness nothing escaped her observant eye.

The most concentrated value of the book is in the Appendix, and no one travelling there again will go without a copy of it. Miss Stark's principal interest in the country was the Incense routes and for this reason her book is well named. In ancient times, the South was very much the front door of Arabia, for through it the goods entered on their way from the East to the West. There can be no more fascinating subject for an important book than the whole history of the trade with the East, from the dawn of history, through Venetian times, down to and after the discovery of the Cape by the Portuguese, and it is this earlier part concerned with the Incense routes that requires most research. Miss Stark starts with a summary of the relevant parts of the *Periplus*, than which there is no more delightful guide to the sea ports of Arabia and Azania.

At Mukalla she was received with his customary kindness by Sultan Salim bin Ahmed, Regent of the Qu'aiti state in the absence of the late Sultan. At all hours there are to be seen sights there which form ready material for Miss Stark's pen. When she saw the graves and ruins on the top of Qarat al Mukalla she was viewing the ruins of old Mukalla, the first stronghold of the Kasadis. That they should have settled on the barren top of a mountain 1100 feet high with no water supply shows how insecure they felt.

None of those of us who have travelled in the Hadhramaut has yet been able to stay long enough to claim finality for our statements, so that if occasionally I differ from Miss Stark I do so tentatively. For some time yet different travellers

must co-operate to check each other; the important thing is that each should record all he learns in the hope that others may be able to verify the statements of a single informant.

Tila as Sufla has now become the recognized junction where travellers for the interior change from car to donkey. Here Miss Stark spent a night and met the venerable Sheikh Muhammad bin Ahmed. He is the Mansab of two of the most important tribes of the Mukalla province, the Beni Hasan and the 'Akābira, but he is not the religious chief of the 'Amudis, for this office is held by the leader of the Motahhar family at Budha in the Wadi Du'an.

At Tila she was shocked by a request for *bakshish*, and it is indeed deplorable that this monotonous cry of the East should nowadays follow the traveller into tribal Arabia. Those who encourage the offence by complying, or commit the analogous crime of vast overpayment for services rendered, will not usually admit it, and the disease spreads so fast that the few Europeans cannot be the only offenders. Indeed, wealthy friends in the interior have defended the custom to me when I have deplored it, on the ground that the people are so miserably poor that they ought to be helped in this way.

If Europeans are not the only culprits in the distribution of *bakshish*, they are also not the only people who do not share the meals of the Badawin on the road. Fares to Du'an by camel and donkey do not depend on the whim or bargaining powers of the tribesmen who work the routes. As one would expect on such well-established caravan roads, centuries of use have resulted in recognized fares and concomitant expenditure, and the variations in these payments, amongst other things, depend on whether the provision of water and firewood for the passenger are included, and whether or not he feeds with his carriers. It is not only the better class Arabs who feed by themselves. The camel men feed apart from the donkey men. The *ma'ras*, or foot porters, feed by themselves; the soldiers and personal servants have another mess. As for the disgruntled Badu's charge that Europeans ride ahead, one of the greatest difficulties I have had has been to keep the caravan ahead of me, so that I might be sure I was taking bearings along the track.

Everywhere Miss Stark's affection for the Badawin appears, and again and again she delights us with kindly and humorous sketches of them, but one may suspect a mild ridicule in her references to the forces of law and order. In such matters everything is relative, and if she were to look at some of the other states of the Protectorate she would see that the Government of Mukalla, and of course that of Lahej, is extremely regular and orderly. She realized the worth of the rule of the Ba Surras in Du'an, but it is misleading to say that they are practically independent of Mukalla, just as it would be to say that a particularly good Provincial Commissioner far out in the African blue was practically independent of his Governor at the capital.

I hesitate to correct Miss Stark's history, but is she right in saying that the Seiyids are descended from the first missionary of Islam who settled in the Hadhramaut? The ancestor of the Seiyids, Ahmed bin 'Isa, who is buried at Hasīsa, near Saiun, arrived in the country from 'Iraq about a thousand years ago, but Ziad bin Dhubeid, the envoy of the Prophet himself, came to the Hadhramaut in the eighth year of the Hejira. By the time Ahmed bin 'Isa arrived the country had had several religious vicissitudes including a period of Ibadhi-ism. The orthodox faith was re-established in A.D. 757, and the man who did it was Ma'n bin Zaida, an historic, not a legendary, personage. It is to Ma'n bin Zaida that tradition attributes the fashions in dress of the Badawin.

Miss Stark naturally fell a victim to the charms of that broad-minded and delightful patriarch, the Mansab of Mashhad. There are two types of Seiyids

existing in the country who are a great power for good. Seiyid Ahmed represents one of them, the old-fashioned kind who spreads good will and settles disputes, domestic and otherwise; and there is the new-fashioned Seiyid who has ceased really to have much claim to sacred office, but employs his energy and wealth in educating the people to modern methods.

The establishment of the Qu'aiti dynasty in Mukalla is not a matter of tradition only, but of fairly recent history, and the dynasty itself cannot claim to be older than the beginning of last century. Indeed it was not until 1882 that they became the paramount rulers in the country.

I am afraid physical geography is against the Wadi Bin 'Ali route being used for a motor track to the interior; the simplest route is the one from Tarim to Shihr, and all who are interested in the progress of the country must hope to see that finished soon. In the same way one may hope that it may yet be possible to cultivate much more of the central wadi by building a dam below Tarim. Much water runs to waste down the Wadi Maseila and every one would benefit if irrigation could be properly developed.

The expression "Sultan of Qatn" which Miss Stark applies to Sultan 'Ali bin Salah gives the idea that he is the established ruler of that town of the Shibam province, but he had, in fact, left all office in November 1934, a few months only before her arrival. It would convey his status and influence more accurately to describe him as Squire of Qatn. Miss Stark proposed to travel to Shabwa under his aegis and rejected the Governor's proffered assistance, though it is true that she continually emphasized her private status. I am sure however that when travelling in a country like the Hadhramaut one should support established authority, more especially if authority is too courteous to insist, and in the Yemen she would have had no option but to do what the Government decided.

All one's sympathy is aroused by the illness which prevented Miss Stark fulfilling her ambition of reaching Shabwa, and one can only be thankful for the opening up of the country with landing grounds which enabled her life to be saved. The more we hear of Shabwa the more interesting it sounds, and the only real obstacle to visiting it is the Badawin's fear that visitors wish to exploit their rock salt. Prior to her visit to the Hadhramaut three Europeans, Boscawen, Rickards, and Helfritz, had passed by the place, and the last-named paid a brief visit to it when she was lying ill at Shibam.

Miss Stark is probably right in thinking that the ruins of Gheibun are buried rather than swept away, buried in the silt that has been brought down by the *seils* of the Wadi Du'an. All through the Hadhramaut the ancients seem to have favoured these wadi island sites, if available, for their strongholds—Hajarain, Gheibun, Shibam, are all examples and there are others in the Wadi Maseila. They all form ideal fortresses to protect a caravan route and to afford temporary safety to its precious cargo. From a picture taken by Helfritz, Shabwa appears to have the same sort of situation.

In truth Miss Stark has written a wonderful book which easily supersedes all earlier works on the Hadhramaut except that of Van den Berg, and will make that part of the Aden Protectorate, which its rulers have declared to be "an appanage of the British Empire," wide known. Those who are not interested in Arabian politics will delight in her sketches of men and women. If reaching Shabwa would have meant the loss of such passages as those in which she tells us of the Learned Lady of Saiun, one is almost reconciled to her misfortune in not getting there.

W. H. I.

REVIEWS

EUROPE

A GUIDE TO SNOWDON AND THE VALE AND PASS OF Llanberis. By VALENTINE DAVIS. *Wistaston, Cheshire: John Francis* 1936. $7\frac{1}{2} \times 5$ *inches;* x+104 *pages; illustrations and sketch-map.* 1s (1s 1½d *post-free*)

It appears that this booklet consists of selections from a larger work, continually referred to as the complete edition, which has already been written and will be published if there seems to be a demand for it. That edition ought to be very much more complete than the present which, as far as Snowdon is concerned, only touches the north-east side and describes ascents from Llanberis and Pen-y-Pass; even so the splendid ridge-walk on Crib Goch and Crib-y-Ddysgyl is omitted. The rest of the book deals with the environs of Llanberis, including the slate quarry, in connection with which the author makes the suggestion, well worth consideration, that the waste rock now being tipped on the mountain side at the rate of 6000 tons a month might be used for making the proposed embankment across the Dee estuary. He must be commended for making a stand against the "modern attempt to popularize the spelling *Caernarvon*, since *caer* is not English and there is no *v* in Welsh." But as he clamours for criticism, may we suggest that he should ruthlessly cut out his extremely irritating puns and should draw an entirely new sketch-map with all names written neatly on the face of it and with the north at the top instead of (for no apparent reason) at the bottom. In the passage advocating the removal of sheep from Snowdon, he should not fail to expunge the doubly inaccurate remark about "sheepless Iceland . . . far within the Arctic Circle." A man—apparently a geologist—who has been up the mountain over a hundred times can surely produce a better book on it than this. J. H. R.

FINLAND: The New Nation. By AGNES ROTHERY. *London: Faber and Faber,* 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* x+258 *pages; illustrations and map.* 12s 6d

This work deals with a country really interesting, not only on account of the rapid strides to nationhood made in so short a time but also as showing the success of the democratic idea when worked out on modern lines. The author begins by conducting us through the maze of waterways constituting the Finnish archipelago, and so direct to the modern city of Helsinki. With such a material as the native granite close at hand, the new national architecture has followed noble lines and the author sees "a new city yet already mature, a city moving to a tempo which is energetic without nervousness and rational without heaviness." Following the author around the countryside, we are impressed by the vividness and precision of her descriptions. Those who have been to Finland will recognize the characteristic touches which make the scene alive; those who have not will be well advised to study this work so as to miss nothing.

The different nationalities that combine to form the population of Finland are described in separate chapters, but it must be remembered that the Finlanders of far-back Swedish origin and the true Finns are really intermingled, especially in the towns, though the latter are numerically predominant. The Russians in the little island colony of Valamo and the Lapps who occupy regions of the bare North are apart.

Many other places of interest are mentioned: the little mountain resort of Koli, wild and lovely; the famous view from Puijo hill, the Rapids of Oulu, the city of Tampere, where the song of the waters is always loud in one's ears.

Finally, we are started on the long journey to the North, through solid-seeming walls of evergreen at first, but gradually passing into a strange, bare region where even the dwarf birch fails.

Part III begins with an account of the Finnish national movement and then describes the remarkable commercial advances made by so young a nation, industry being organized throughout on the co-operative principle. Part IV deals with the Arts, in which Architecture takes the leading place. The lists of places are useful, but contain a few errors.

In the bibliography, the Atlas of Finland should have been mentioned, this being an invaluable work of reference in all Finnish matters. The photographic illustrations are an attractive feature and the index is adequate.

E. G. W.

THE HEART OF PROVENCE. By AMY OAKLEY. *New York—London: D. Appleton—Century Co.* 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xx+478 *pages; illustrations and sketch-map* (by THORNTON OAKLEY). 15*s*

This book deals mainly with the littoral from Saint Tropez to Marseilles, and the valley of the Rhone, Aix, Arles, Avignon, Nîmes, Aigues-Mortes, and Carcassonne, a rich realm of visual beauty with an equally rich background of history and romance. The author catches admirably the temperament of the Provençal as described by Anatole France: "Your fine gaiety, your advised benevolence, your superb scorn of riches, your cult of antique simplicity." She gives a very entertaining record of varied detailed experiences of travel, with history pleasantly woven into the fabric, and the numerous black and white pictures, worthily reflecting the text, are wholly satisfactory. Her powers of lively and attractive description are equal to all occasions, as, for instance, when she describes the cork and silkworm industries at La Garde Freinet. At Arles however she seems shy of the architecture of Saint Trophime, for "to tell of the glory of its cloister transcends the pen." But in these delightful *impressions de voyage* very little escapes the author's observation and enjoyment at Arles or Avignon, Orange or Nîmes. Perhaps the freshest descriptions are those of the "iridescent Camargue," guardian of the threshold of Provence, and of Les Baux with its echoes of the Troubadours.

S. E. W.

ASIA

THE MAKING OF MODERN IRAQ. By HENRY A. FOSTER. *London: Williams and Norgate,* 1936. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* x+320 *pages; maps and frontispiece.* 15*s*

Mr. Foster is to be congratulated on the industry he has shown in compiling the immense amount of detail contained in this book, and also on an unusual freedom from prejudice in his treatment of matters which in their time caused a great deal of controversy. But he has not thrown much new light on a subject which has already been adequately treated, notably in the Survey of International Affairs, and also in the numerous books, articles, and pamphlets mentioned in the bibliography appended to his own book. That Mr. Foster does not bring first-hand knowledge to his treatment of the subject is of course not his fault. But the fact detracts considerably from his account of 'Iraq's internal progress; while the chapters dealing with the international factors in the emergence of this new state, the early attempts at foreign exploitation, the stress of war inducing more liberal treatment, the growth of the mandatory idea, the series of bargains and compromises by which the status of 'Iraq was ultimately established—all these matters, which are beyond the normal range of any one

individual's first-hand knowledge, but which evidently constitute Mr. Foster's favourite theme, are handled with a lack of definiteness.

This may be largely due to the defective arrangement of the book. Six chapters are devoted to an exposition of the international factors: an exposition coloured by the author's enthusiasm for the mandate conception and President Wilson's share in inventing it. This conception runs like a golden thread through the sordid tale of international intrigues, of "struggles for oil," and of "secret agreements." But the thread is often in danger of being lost, as the course of the narrative sways backwards and forwards, alternating from international politics to internal administration, and back again. Chapter III, for example, anticipates in its latter part much of chapter V, while chapter IV interrupts the train of thought. Chapters VI and IX might with advantage have been amalgamated and chapter X merged in chapter IV, of which it appears to be an expansion. Hence much needless repetition, as in the story of the "struggle for oil," which is recounted in two distinct chapters.

Greater compression might have made the exposition of causes clearer while giving a more precise picture of the facts. The exact contents, for instance, of the various "secret agreements" for the partitioning of the Middle East would have been interesting information; but, in spite of pages of animadversion on these deplorable activities, the passage (p. 44) on which they are specifically related somehow omits to give the precise details; and the connected map on p. 45 leaves the reader equally in the dark. A perusal of these chapters and of the concluding summary gives the impression that the author was labouring under grandiose ideas over which he had a very imperfect control.

On the other hand, it is refreshing to find that, through all this incoherence, and in spite of his predilection for Western (and especially Wilsonian) ideals, the author contrives to keep his mind open and his judgment impartial in his account of such matters as the question of the "open door" in 'Iraq, the diplomatic encounter between the United States and Great Britain over "Mosul" oil, in his exposure of American tendencies to yield to the temptation of economic and imperial expansion, and in his doubts as to the real permanence of the League's settlement of the Mosul boundary dispute.

In contrast, we seem to detect a slight disingenuousness in the omission of any reference to the notorious Assyrian incident. The book was apparently written in 1935, and the incident occurred in 1933. It was a rude shock to 'Iraq's sponsors in the League, and to mention it would perhaps have been a sharp challenge to the enthusiasm which Mr. Foster retains to the end for this experiment in international trusteeship. The omission is the stranger in that Mr. Foster gives prominence (p. 275) to the Bahai case, which in comparison was a minor domestic incident. But by this time perhaps he could see nothing paradoxical in welcoming the disappearance of the mandate as warmly as he had acclaimed its inception; nor does he show any suspicion that, in the irony of history, the experiment had actually turned out far differently (though not less beneficially) from that which its authors had ever imagined.

The account of the internal government of 'Iraq is even less satisfying. Here the lack of personal knowledge is more serious, and we are given little more than a mechanical précis of official reports, with elucidations (where the author thinks them necessary) derived from other second-hand sources, many of them tendencious or partial. The result is blind guidance indeed. An example or two will suffice. Commenting (p. 221) on the apparent underspending in the years 1915–20, the author ascribes the defect to Great Britain's "extremity of resources" at the end of the war. This sounds like an echo of the Press campaign on the subject of the "taxpayers' millions thrown into the sands of

Mesopotamia." Internal expenditure was not the concern of the British Treasury. The real reason for underspending was the general uncertainty as to the future. Mr. Foster shows little appreciation of the extent to which the local administration was retarded and perplexed by the fluctuations of external policies. Again, the remark (p. 207) that "land must necessarily be the Government's chief source of revenue," is a pious but inaccurate utterance. Customs and excise are the chief source of revenue and the tendency is to diminish the demand from land revenue, for obvious political reasons.

A more surprising statement is that on p. 203, where the author says that the ultimate form of the 'Iraqi government was taking shape during the years 1914–1920. This is surely loose thinking. The administration during those years may have been a fair example of British "colonial technique" (which Mr. Foster cordially admires), and may have embodied (as elsewhere, *e.g.* in India) the spirit of trusteeship; but to confuse this with the system eventually devised to incorporate the new mandatory principle and the idea of responsibility to the League is to betray a very clouded conception of the real nature of the political experiment illustrated in the recent history of 'Iraq; and a greater contrast, in respect of systems of government, can hardly be imagined than that between the direct British administration of 1918–21 and the succeeding 'Iraqi constitution.

There is in fact too much rather vapid writing in this book. We want a more concrete statement of facts. What is the real character of the new State which has been cast up, so to speak, by the ebb and flow of international tides? Where does the real power reside? What is the relation of the tribes to the government? Is the government merely a Baghdad close corporation? Which are the personalities that count? How far is 'Iraq a self-supporting, self-defending, entity?

These and similar questions arise, and remain unanswered. The internal administration has tended, in recent years, to go underground, so to speak, and little is known of what is happening. Its external relations, with Turkey, Persia, Saudi Arabia, and Syria, which are probably of first-rate importance, are hardly touched upon. We look in vain to Mr. Foster for light on the real problems; and we can only hope that a more realistic historian of 'Iraq will in due course arise.

S. H. S.

AFRICA

A PROVISIONAL SOIL MAP OF EAST AFRICA. By G. MILNE. *Amani: E. African Agric. Res. Statn.* (*London: Crown Agents*), 1936. 11 × 7½ *inches; 34 pages.* 5*s*

The appearance of this first large-scale soil map of East Africa is an event for the geographer, for whom it will provide a clue to the little that is known, to the comparatively large areas for which intelligent conjecture regarding the soil pattern is justifiable and to the still larger areas over which even conjecture is not as yet permissible. We must therefore admire, and be grateful for, the author's courage and enthusiasm without which the material at his own and his collaborators' disposal would probably never have been used, for what in the minds of many will probably be looked upon as a premature attempt.

The map can not, of course, pretend at the present state of our knowledge to be of much use to the practical tiller of the soil; but notwithstanding its many blank spaces it already gives a fairly clear picture of the general distribution of a well-chosen though wisely limited number of major soil types, classified on a morphological basis; and this picture is sure to assist greatly all those who are concerned with the fundamental nature of the soils and their relationship to

each other and to the associated factors of climate, topography, parent rock, drainage, vegetation, and human activities.

Of great importance for the easy mapping of large regions over which two or more soil types repeatedly dovetail into one another in accordance with the topographical detail, is Mr. Milne's new concept of the "Catena," and the "pyjama stripe pattern" chosen for signifying such catenas is both easy to grasp and pleasing to the eye. It should however be noted that the greens and blues and the reds and oranges, though clearly distinguishable in daylight, become somewhat indistinct in electric light. The present reviewer is so much impressed by this catena concept that he wishes to see it extended from soil to soil- and moisture-determined dovetailing vegetation types. If this were done the close interdependence of soil and vegetation in many parts of East Africa would probably become immediately much more conspicuous than it is at present. On the other hand, the soil map when compared with the reviewer's recent population map of Tanganyika Territory, does not show any striking connection between soil types and population density, and thus bears out the suggestion that the latter primarily depends on permanent supplies of domestic water.

The colouring of the map is discreet and pleasant, but in a future edition, which one hopes will soon follow the first, the "rubber-stamp" impression of much of the lettering (especially of the superimposed descriptions in purple) might be replaced by more carefully executed type.

The accompanying text is not only clear and concise but shows that much geographical insight and a sound modern "philosophy of the soil" rank high among the author's qualifications. Both map and text will thus be indispensable to any one interested in East African Geography and will, it is hoped, encourage others to undertake similar painstaking work for other parts of Africa. C. G.

A POPULATION MAP OF TANGANYIKA TERRITORY. By C. GILLMAN. *Government Printer: Dar es Salaam* 1936. $12\frac{1}{2} \times 8$ *inches*

These documents possess a significance much wider than that of most Colonial reports and much greater than the brief text of fifteen pages would seem to indicate; this because the latter deals with fundamental geographical factors as they affect the density and distribution of African population in sub-humid and semi-arid climates. Colonial officials capable of dealing analytically and synthetically with this subject are all too rare. But the Government of Tanganyika Territory has wisely realized the advantage it possesses in this respect; and it is to be hoped that other administrations will appreciate the benefit that would accrue from similar investigations in other parts of Africa. To this end the text accompanying this population map ought to receive wide publicity, since the facts and influences which it describes are applicable in varying degree to vast tracts of the continent. It should however be mentioned that the brevity of Mr. Gillman's report has necessitated much compression, and that some of the greatly condensed references to such matters as geomorphology and soils, though clear to the expert, may lose some of their significance for the layman.

The maps compiled by Mr. Gillman are: first, that showing population distribution (1 : 2,000,000) and secondly a map (1 : 4,000,000) of novel character showing the distribution of eleven types of land occupation, with the extent of the tse-tse areas added. Both maps were admirably drawn on the scale of compilation—twice that of the printed maps—by a Swahili draughtsman, and they have lost little by reduction. On the first map population is shown by the dot method (a 200 dot and a 50 dot) but with areas of over 150 per sq. km. (*c.* 400 per sq. mile) shown solid, and with proportional "spheres"

for townships of over 4000. This map is supplemented by a well-devised index of reliability. Nearly two-thirds of the Territory are entirely uninhabited, while the one-fifth of the country which has good or fair domestic water supplies harbours five-sixths of the people. Thus the explanation of the very irregular distribution of population is shown to lie first, and chiefly, in the distribution of domestic water supply, determined in turn by climate, land form, and physical soil conditions. The other influences at work are the tse-tse fly, and, in minor degree, soil fertility. Mr. Gillman's opinion of the relations of tse-tse to population may be quoted: "Against an extending or stationary human population, dense enough to keep the natural vegetation which harbours fly permanently down, the latter has no chance of surviving. Where on the other hand . . . human pressure relaxes and a secondary vegetation suitable as a habitat for fly is thus allowed to capture or recapture the land, fly immediately follows in its wake. We must, thus, divorce ourselves from the view still widely held, that fly drives man away; it is man who recedes, generally after having exhausted soil and shallow underground water and leaves the wasteland to tse-tse. Somewhat more complicated is the case where man with his methods of shifting cultivation becomes a pioneer intruder into the vast dry savannah forest, usually in numbers far too small to keep his temporary clearings efficiently open. In this case man, obviously, is the aggressor and becomes a competitor, with all the risks this involves, of an insect apparently very much better adapted to a semi-arid environment."

The bulk of the text is devoted to a most interesting account of the following human habitats: High Rainfall Cultivation; Alluvial Plains and Scarp-foot Fans; Cultivation Steppe; Highland Savannah Settlement; Coastline Hinterland Settlement; Dry Savannah and Thorn Settlement; Townships; Nomadic Occupation. In regard to the Masai Steppe, in the last category, the author questions whether it does not represent "the end-product of man-created soil deterioration and desiccation; whether, in other words, a former and probably dense sedentary population has not been forced by increasing impoverishment of soil through soil erosion and by a corresponding lowering of the groundwater table to evacuate their home lands, leaving them to the less exacting nomads and repeating the process of destruction elsewhere at the present moment!"

Throughout the Territory many of the "oases" that constitute the closely populated part of the country have reached, or are dangerously near, congestion with its consequence of soil and water exhaustion. Yet the vast remainder of the land is in no condition to absorb emigrants from such areas. The author considers that the solution of this supreme problem for Tanganyika involves action of two kinds: first by promoting a more enlightened soil and animal husbandry in the oases to mitigate and eventually to stop the deterioration there; and secondly, by storing the water that now runs off and by tapping the lower ground water to provide the water without which the present wastelands can never be occupied. A. G. O.

IN LIGHTEST AFRICA. By H. T. KENNY. *London: John Murray*, 1935. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* x+196 *pages; illustrations and sketch-map.* 10*s* 6*d*

'In Lightest Africa' is not a text-book on 'Afrique Blanche,' nor is it in any sense a book of adventure. It contains no incident of a more desperate nature than a failure to get home one evening by motor car owing to a sand-storm: it is not even in essence a narrative, though it adopts the narrative form. Mr. Kenny's object is rather different. He has chosen to outline with an authoritative and comprehensive pen, conditions in the French Sahara immediately south of the Atlas Mountains, in the light of his own considerable personal experience.

To the general reader, in spite of the title, this district is rather darker than Once-Darkest Africa, because it is a little too remote for the ordinary tourist, and yet too "safe" for the seeker after thrills.

No one after reading Mr. Kenny's book can continue to think vaguely of Langhouat and El Golea, as the sort of places where Cape Fliers crash a little off their course. 'In Lightest Africa' is in no way technical: it is simple and easy to read; the anecdotes are well selected and pleasantly told. Particularly entertaining is the story of a disastrous dinner-party with Haj' Mabrouk. Relations with Arab and with French officials, negro dances, the bargaining for houses, the devotion of the Post Office at Langhouat to its pens and papers, are only a few of the many sides of life touched on in this picture. Mr. Kenny has a word to say on the famous Women of the Ouled Nail, and several words of welcome common sense about the Foreign Legion. He sketches in something of the past of the district, not forgetting the work of General Lapperine and the Révérend Père de Foucauld: he goes into the not very great scope that is offered for trade and development. He devotes one chapter to the sparse but interesting desert fauna and another to his journey to El Golea in the south.

Mr. Kenny is interested in every aspect of the oases but particularly in life as it may be lived there by the enterprising English settler—as it was lived by himself and by his wife. K. C. G. D.

NORTH AMERICA

HISTORIC SPOTS IN CALIFORNIA: Valley and Sierra Counties. By H. E. and E. G. RENSCH and MILDRED BROOKE HOOVER, [under the aegis of] "Daughters of the American Revolution." *Stanford (Calif.): University Press—London: H. Milford* (1933). 8×5½ *inches;* xxiv+598 *pages; sketch-map.* 17*s*

This book is the second of a set of three volumes, which, taken as a whole, are planned to describe the topography of California from a special point of view. The work here under review deals with thirty counties, which are called "the Valley and Sierra Counties," and cover the northern and central parts of the State. The treatment is by counties arranged in alphabetical order. The historical incidents associated with the places of each county are described, an average of about twenty pages being allotted to each unit; every section is followed by a full bibliography. This is a difficult book to read through as a whole, but the object of the series must be remembered by any critic. The purpose of the book is stated to be threefold, "to create interest in the local history of California among its citizens; to make knowledge of the historic spots of the different localities available to the inquiring tourist; and to arouse a state-wide desire to preserve those vanishing landmarks which still survive." Special attention is given to monuments which have been erected to explorers and pioneers, and there is no doubt that this kind of information will be of interest to tourists. The area covered by the volume is now one of great agricultural activity, and its history does not go back very far. There were not many Spanish settlements in this region, but it includes many of the mining camps that grew up in the days of the gold rush of 1849. These places enjoyed a short period of prosperity and then rapidly declined, so that a large number are now "Ghost Towns," and have an almost archaeological interest for the Californian. There is a useful description of Traver, a place in Tulare County, which shows that there are ghost towns in agricultural as well as in mining history. The story of these ghost towns and of places like Sacramento, as well as the detailed history of the routes and passes that were first used across the

sierra are all of value to geographers. Nevertheless, the alphabetical arrangement of the material by counties is likely to make the volume of far greater use to the people of California than to general readers not resident in that State. A good index and a small map of the counties are included in the book. E. W. G.

CENTRAL AND SOUTH AMERICA

FUENTES DE LA HISTORIA CULTURAL DE LA AMÉRICA PRE-colombina—Quellen zur Kulturgeschichte des präkolumbischen Amerika. [In Spanish and German.] By H. TRIMBORN. (Studien zur Kulturkunde. Edited by LEO FROBENIUS. Dritter Band.) *Stuttgart: Strecker und Schröder*, 1936. $8\frac{1}{2} \times 6$ *inches;* xvi + 262 *pages. M.*9

This German–Spanish work deals with the cultural history of South America before Columbus. It gives the text of three sixteenth-century documents, of which one has remained hitherto unpublished and the two others have been available only in defective versions. The first document, the MS. of which is now in the Biblioteca Nacional, Madrid, lay for many years forgotten in the archives of the former Spanish Colonial Ministry. It consists of geographical and ethnographical notes on Peru compiled in 1597 for the viceroy by his chaplain, who had worked for some twenty-five years as a missionary, and had moreover accompanied his master's predecessor on journeys of inspection to the most remote parts of the country. He states that his information is mainly based on personal experiences, and it is interesting to note that in 1906 this document was officially placed before the Argentine Government in connection with a dispute regarding the frontiers of Bolivia.

In a first section the author of the notes makes a general survey of the entire territory, giving details regarding its topography and hydrography, its climate, its vegetation, and its fauna, and a description of the natives, their customs, and their dress. What he has to say about the psychology of the Indians shows that he was a shrewd observer. This is followed by a section containing similar data with special reference to the regions within the jurisdictions of the Archbishop of Lima and the Bishops of Quito, Cuzco, and La Plata. The statistics regarding the population are unfortunately not always given in accurate figures. Trimborn emphasizes the fact that the author of the manuscript, unlike the majority of his contemporaries—mainly concerned with social, juridical, and religious questions—has given material civilization a due share of his attention.

The second document, "La Guerra de los Chichimecas" (written between 1571 and 1585), although mainly an apologia for the war waged against the primitive tribes of hunters known under the general appellation of Chichimecas, contains a certain amount of data which sheds new light on the history of the Conquista and the colonization of northern Mexico, besides giving details which will be valued by archaeologists and ethnographers. Trimborn considers its publication *in extenso* "an urgent necessity" for the investigation of the cultural history of Mexico, reminding us that the primitive culture of the Chichimecas begot the highly developed civilizations of other peoples of Central America. There seems to be some doubt regarding the identity of the writer of the manuscript and the authenticity of the document itself, of which three versions exist—the one now edited by Trimborn, the MS. of which, hitherto unpublished, is in the Library of the Escorial, the one in the Bibliothèque Nationale, Paris, and the one included in 'Extractos y Noticias de Manuscritos relacionados con la Historia de México,' compiled by José Fernando Ramirez. In a most painstaking and scholarly investigation of the points at issue, Trimborn

strongly inclines to the view that the Escorial version is, if not actually the original, a faithful copy of it, whereas the two others appear to him merely bad copies with numerous omissions; and he also proves fairly conclusively that the author was Gonzalo de las Casas, a relative of Fernando Cortés.

The third document, hitherto known only in the defective version published in vol. 50 of 'Colección de Documentos inéditos para la Historia de España', is the official report (dated 1558, *i.e.* only twenty-five years after the conquest of the region) of two ecclesiastical visitors on the system of government which obtained in the valley of Chincha before the Incas and under their rule. The scarcity of early documents bearing reference to civilization on the coast lends special importance to the manuscript in the Library of the Palacio Nacional, Madrid, now edited by Wilhelm Petersen. It contains much information regarding the religion and the social organization of the natives; and the details given about the laws regulating inheritance are especially interesting. In his introduction Petersen analyses the various cultural features and endeavours to draw a dividing line between those that are traceable to Inca influences and those that have an earlier origin.

Each text in the Spanish of the sixteenth century, with its clumsy syntax and erratic punctuation, is followed by an admirable free translation into German. This brings the book, primarily intended for professional historians, within the horizon of the ordinary student. F. M. M.

GEOLOGIE SÜDAMERIKAS. By H. GERTH. Zweiter Teil. (Geologie der Erde. Edited by ERICH KRENKEL.) *Berlin: Borntraeger* 1935. 10½×7 *inches;* vi+201–389 *pages; illustrations and maps. M.*19.60

The first part of this work was reviewed in our February number. In this second part the Mesozoic formations of South America are described. The Triassic system is represented by the Upper Trias (Carnic, Noric, and Rhaetic) only, and is partly of continental, partly of marine facies. The former has yielded a remarkable reptilian fauna of South African affinity in the Parana basin; it occurs also in Guiana and North Brazil, and in the Eastern Cordilleras of Bolivia and Argentina, while the marine facies is confined to the Central Cordilleras of Peru, Chile, and Argentina. Thus the marine transgression is Pacific, and this continues through the first half of the Jurassic period (up to Callovian), and is repeated towards the end of that period, continuing into the Lower Cretaceous (Kimeridgian to Cenomanian). Only towards the end of the Cretaceous period are there found evidences of the existence of a South Atlantic Ocean, in the form of marine transgressions on the east coast of Brazil and Patagonia. This part maintains the high standard of the first, and contains a great store of information nowhere before brought together. A. M. D.

AUSTRALASIA AND PACIFIC

NORTH AUSTRALIA. By C. PRICE CONIGRAVE. *London: Jonathan Cape,* 1936. 8×5½ *inches;* 320 *pages; illustrations and map.* 10*s* 6*d*

The author of a book of this kind should state his credentials. Beyond telling us that he spent fifteen years in the country, Mr. Conigrave says nothing of his title to write the book. In 1912 he led a small expedition to the Kimberley country, Western Australia, which was briefly reported at the time, both in the *Journal*, vol. 39 (1912), p. 493, and in *Petermanns Mitteilungen*, 58, i (1912), p. 278. Australian official publications show that he was on the clerical staff of the Mines Department at Darwin from 1913 until about 1925, when he became Inspector of Fisheries at Darwin. This explains why his first-hand

description is confined to country within about 150 miles of Darwin, mainly along the coast. The book is a general and historical description of North Australia. Mr. Conigrave believes in the country, and gives a convincing account of its undeveloped mineral, pastoral, and marine resources, and of the disadvantages, mainly political in his opinion, which have hampered their development. The book is interesting to read. Narratives of trips to Bathurst Island and the Daly river are unusually entertaining, and his running commentary on the aborigines, especially on the Larrakeah of the Darwin district, with whom he is most familiar, is both sympathetic and amusing. He conveys a very clear idea of Darwin itself and of the year's round of life there; and he succeeds in communicating a feeling of uneasy wonder that a country of such varied mineral wealth as North Australia should remain, after a century of nominal occupation, almost empty. M. A.

CARTOGRAPHY

THE EAST AFRICAN ARC. By BREVET-MAJOR M. HOTINE, R.E. Reprinted from *The Empire Survey Review*, Nos. 12, 14, 16, 18 (1934–35)

This account deals with the geodetic triangulation carried along the eastern side of Lake Tanganyika during 1932 and 1933, under the direction of the author, Major Hotine. The chain extends northwards from the northerly termination of the 30th Meridian Triangulation in Northern Rhodesia, to the southern boundary of the territory of Urundi administered by the Belgians; and it forms one more important step towards the completion of the great project of the 30th Meridian Arc Triangulation in Africa. The account is a reprint from *The Empire Survey Review*, in which it appeared in four instalments. It is a technical report, written by a surveyor for the information and guidance of his professional brethren. It deals very methodically with all the practical, and a good many of the theoretical, aspects of the operation. The first section treats of the lay-out of the triangulation and gives the guiding principles observed, the reasons for various measures adopted, the provision for connection with adjoining work and a detailed and interesting account of the actual reconnaissance. This is followed by a section on marks and beacons, in which the question of signals for high-class trigonometrical observation is fully discussed, and details given of the apparatus used. The general organization for light-showing, station preparation, communications, etc., is all discussed in minute detail.

The section on observation deals with instruments, methods of observation and records. The Tavistock theodolite is highly commended; the Wild, on the other hand, developed axis trouble. The interesting point is raised why surveyors in different parts of the world differ so widely in the number of measures considered necessary—varying from eight in South Africa to thirty in India. The author considers that the two essentials in observing are symmetry and speed. In order to ensure the former he recommends that observations should be made in such a manner that, if interrupted before completion, there shall always be a symmetrical set available; thus zeros should be taken 0°, 90°, 45°, 135°, 22½°, 112½, etc. The second principle is based on the assumption that, whatever care is taken, the instrument, atmosphere, ground are all moving to some extent, and that the quicker the observations are taken the less movement there will be. All surveyors of experience will be disposed to agree.

Most of the observing was done at night, on lamps; and it is noteworthy that these were electric, the power being obtained from batteries. In discussing daylight work, Major Hotine advocates observing (on helios) during the two hours after sunrise and the two before sunset. The recollection of the writer is that experience on the 30th Meridian Arc in Uganda was against this. It is true that lights appear clear and steady when the sun is low; but after some

experience these conditions were viewed with suspicion, as there seemed to be a tendency to lateral refraction. On the other hand, although when the sun is high signals become very unsteady and observation much more difficult (necessitating a greatly increased number of pointings), the results appeared to be more reliable.

The fourth section, on base measurement, gives a detailed description of the "Macca" base measurement gear which was used, and of all the methods adopted. The gear was designed by McCaw and constructed by Cooke, Troughton and Simms. It seems to have been eminently satisfactory, a result due, as the author points out, to the co-operation of the practical surveyor and the skilled instrument maker.

Invar tapes were used, the unit of measurement being the foot. On the scales at either end of the tapes the foot was divided into five hundred parts, so that by estimation the scale could be read to a tenth of these divisions, or 0·0002 foot. It would be of interest to know if this somewhat peculiar division of the foot is as convenient to read as the millimetre.

We note a small error on p. 4, where a reference is made to "diagram, p. 8," which was doubtless correct in the original, but no longer applies in the reprint. And on p. 29 it is said that "the vertical circle is best left clamped during a round of horizontal angles." Surely this should read "*un*clamped."

It is clear from this interesting account that the triangulation for this portion of the Arc was carried out under very stringent conditions, imposed by the necessity for rigid economy (which implies speed), added to the great natural difficulties of survey in this part of Africa. The success with which the work was done could only have been attained by the most careful organization, devised and directed by a clear brain. The report is full of the most useful information, and will well repay careful study by any one who has to carry out any survey work, primary or otherwise. E. M. J.

ECONOMIC AND HISTORICAL GEOGRAPHY

THE LIFE OF SIR HENRY MORGAN, with an Account of the English Settlement of the Island of Jamaica (1655–1688). By Brig.-General E. A. CRUIKSHANK. *Toronto (and London): The Macmillan Company of Canada*, 1935. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 448 *pages; illustrations, plan, and map.* 21*s*

The writer dedicates this book to Jamaica, "most beautiful of islands, in commemoration of the 300th anniversary of the birth of . . . Morgan." He has devoted a great deal of research to his work, which however suffers perhaps from its dual character. In the main it is the biography of a prince of privateers and a colonial pioneer in the expansion of England. In part it is a rather indigestible history of the early British settlement of Jamaica. The proportion of quotation is enormous, throughout the whole book, and rather overwhelms the reader who is not a specialist in West Indian history. There is an abundance of excellent material, but hardly an interesting presentation of a vivid historic drama. Copious reference has been made to the Calendars of State Papers, to the Acts of the Privy Council, and to the documents in the Record Office at Spanish Town: and the author has consulted carefully such works as Esquemelin's 'Bucaniers,' Southey's 'West Indies,' Dampier's 'Voyages,' and Gardner's 'Jamaica.' Much care has been taken to investigate the value, credibility, and true authorship of 'Esquemelin': and General Cruikshank, like other recent inquirers, is convinced that "Alexandre Olivier Esquemelin," "Exquemeling," or "Oexmelin," was Hendrik Barentzoon Smeeks, a Dutch Defoe, of Zwolle in Overysel, whose 'Krinki Kesmes' (1715) is said to have helped in the inspiration of 'Robinson Crusoe' (1719). From the famous and

fascinating book 'De Americaenshe Zee-Roovers' the general reading public derived an impression of Morgan not only as an unscrupulous adventurer, but as an extremely cruel, vicious, and dishonest pirate, blotting out all his honour by his tyrannical cruelty towards the conquered. And not the least interesting part of General Cruikshank's study is his account of the libel-suits against the publishers of the first English translations, with their demands for £10,000 damages in each case, and their settlement for £200.

It would have been of value for any good estimate of the life and character of Morgan if we could discover those original private letters of his, which gave Bryan Edwards, the Jamaica planter, so favourable an idea of him. For if they manifested such a spirit of "humanity, justice, liberality, and piety" as Edwards describes, we might be forced to the planter's conclusions: that Morgan was grossly maligned or else the "greatest hypocrite living," which was a character "ill-suited to the frank and fearless temper of the man."

The volume is full of meat and instruction. Among many other things it illustrates well the radically unbusinesslike character of Spanish colonial rule, of Spanish military and naval organization and conduct. Long before Morgan the Spanish world-power had shown its inherent inefficiency, its deep incapacity for the great part to which Fortune, by Divine inadvertence, had called it. Morgan added fresh proofs of what was more fully revealed in the next four decades, after 1688. R. B.

GENERAL

THE PILOTS' BOOK OF EVEREST. By Squadron Leader the Marquess of DOUGLAS AND CLYDESDALE and Flight-Lieutenant D. F. M'INTYRE. *London: William Hodge & Co.*, 1936. 9½×6 *inches;* xvi+208 *pages; illustrations and maps.* 10*s* 6*d*

This book is a little disappointing in that although the authors claim to be filling a gap in the reports of the Houston Mount Everest Expedition of 1933 they do in fact present very little material relevant to the purpose of the expedition that is not already available in 'First over Everest.' Of the present book the most interesting chapters are VI, VII, VIII, and IX, which describe the actual flights to Mount Everest. As in the first, much space is devoted to social occasions in India. The greater the pleasure, then, when the narrative finally brings the reader to the region above the 20,000-foot-thick layer of haze lying over the plains. At that height "the aeroplanes seemed to be enclosed within a semi-circle of the most gigantic mountains in the world; . . . this arc of great mountains appeared detached from the earth and suggested an eerie land floating in a drab sea somewhere between earth and sky."

To continue the journey to the mountain the machines had to steer well up-wind to check the set of the prevailing wind from the north-west; at the same time they had to climb another 11,000 feet. At these heights an oxygen supply and electrically heated clothing are necessary: the customary paraphernalia of flying at great altitudes. The fantastic element in this adventure is the juxta-position of high flying with the difficulties of having to manoeuvre between most terrestrial obstacles. Near Mount Everest the wind's speed almost annulled the machines' progress, so that an aircraft became a nightmare apparatus deprived of its major capabilities, to move rapidly and to climb. "We crabbed sideways towards the ridge, unable to determine whether we were level with it or below." Just as the climber on Mount Everest has to reckon progress in inches where it would usually be in feet, so an aeroplane gains only feet where otherwise it would be miles.

Both the authors insist on survey as the great justification of their effort, and it is curious to know that any other than a professional surveyor would

think as he flew over the summit: "Well, we are over the top, but what a failure from the survey point of view." The failure was that the machines were unable to keep to the prearranged courses. When at the end of the first flight it appeared that the survey film really was fogged and valueless (just how this happened is not explained), a second flight had to be arranged. This, because of the matter of the aircraft insurance, was against the wishes both of the leader on the spot and the committee at home, and some space is devoted to justifying the pilots' conduct in taking the matter into their own hands, securing on the second flight the series of verticals which were plotted and described by Lieut. Salt (*Geogr. J.*, February 1934).

To fly twice over Mount Everest was a fine achievement, well told in those chapters named. But since they insist that survey and not spectacular achievement was their purpose, it is desirable to remark that from a surveyor's point of view the effort seems to have been misdirected: much trouble was taken to get vertical photographs that could give only a negligible amount of map. The authors are confident of the suitability of their method and the success of the results; but the possibility of using the survey cameras to take oblique photographs over wide tracts of country seems never to have been considered. The many beautiful and more intelligible photographs which illustrate the book are taken with uncalibrated cameras, so that plotting from them must always be very far from precise; yet with a series of calibrated obliques such as the four flight tracks could have given, a wonderful map of the Mount Everest region might have been plotted in conjunction with the existing ground surveys. Happily the authors are immune from any revaluation of the survey achievement. "Whatever others may think of our work, we were fully satisfied with the product." M. A. S.

CUSTOM IS KING: Essays presented to R. R. Marett on his Seventieth Birthday. Edited by L. H. DUDLEY BUXTON. *London: Hutchinson's Scientific and Technical Publications*, 1936. 9 × 5½ *inches;* xiv + 326 *pages; illustrations and maps.* 12*s* 6*d*

This volume contains a collection of essays presented to Dr. R. R. Marett by a number of his old pupils and colleagues in commemoration of his seventieth birthday, edited by L. H. Dudley Buxton. There is an appreciation of Dr. Marett's work written by the Editor, and a complete bibliography of his scientific writings compiled by T. K. Pennington. In the Preface the Editor explains that the reason why the volume is not as representative as had been hoped is due to the short period available for its preparation; this may be so, but the list of those who have made contributions should afford great pleasure and gratification to the recipient. In a collection of essays such as this, written by specialists in their own subjects, it would be invidious to single out any for special notice unless one adopts some principle of noting only those concerned with special subjects, and essays dealing with evidences of movements of people and culture drifts have been selected. Henry Balfour describes an interesting Naga-Melanesian culture-link; C. G. Seligman has a note on Rhytons from Hellenistic Egypt, China and Mesopotamia. O. G. S. Crawford gives an interesting account of the routes by land and sea connecting Ireland and England with the Continent of Europe in early times, and Diamond Jenness deals with the prehistory of the Canadian Indians and their migrations together with those of the Eskimos. R. M. Dawkins deals with the curious association of Greeks and Varangians in Byzantium in the tenth and eleventh centuries.

The remaining essays deal more particularly with the sociological and religious aspects of anthropology, and make a valuable contribution to our knowledge of these matters. E. B. H.

THE MONTHLY RECORD

A JOURNEY IN ARABIA

News recently received from Mr. H. StJ. Philby informs us that during the past summer he has successfully carried out another extensive journey in Arabia. Starting on May 19 from King Ibn Saud's camp at Ashaira, on the Mecca–Riyadh caravan route, he reached Abha, the capital of Asir, on June 4. There he spent a little over a week, mapping the surrounding country and collecting specimens. Leaving Abha on June 13 he set his course for Najran, which he reached on June 26. He spent nearly a month there in extensive mapping and collecting. Setting out again on July 24 he paid a visit to Shabwa, the ancient Himyaritic capital, investigating the ruins thoroughly, particularly the temple of Astarte.

On August 17 the traveller reached Shibam, and a stay of a week there enabled him to visit the Saiun and Tarim districts. Having done that he started on his return journey through Najran, but before he had gone far one of his cars, or vans, unfortunately broke down and he was obliged to return to the coast in order to get the necessary repairs effected. He reached the Indian Ocean near Shihr on August 29 and proceeding on to Mukalla had to possess his soul in patience for a considerable time, getting his no doubt sorely tried transport ready again for the road. That done he set out again on his return journey into Saudi Arabia.

His journey from Ashaira to Shabwa is an important exploration, of which we shall hope to have a full account in due course, with considerable additions to the existing maps. One may hope also that the inscriptions which he has collected will throw new light on the ancient kingdom of the Himyarites.

MODIFICATIONS TO THE WILD THEODOLITES

There have been references during the past few years in many publications to some bold alterations to the axes of Wild theodolites made by J. L. Rannie and W. M. Dennis, two officials of the Geodetic Survey of Canada. They have recently published in the *Canadian Journal of Research* (Sec. A, vol. 14, May 1936), a paper entitled "Axis strain in theodolites, its effects and one method of removal." The fact of axis strain itself had been observed and a cure worked out before the methods of testing and separating errors described in the paper had been developed. The design and machining had become too refined for the material of which the axes were made, so that "minute deviations from cylindrical form existed in the steel cylindrical alidade and telescope bearings of a number of Wild Precision Theodolites, owing probably to slight dimensional changes in the metal during the years following manufacture. These imperfections of form produced changing strain in the steel axes as they revolved, and, through transfer of the strain through the instrument, caused changing deflection of the line of collimation which occasioned, in the measured values of angles, errors as large as two to four seconds of arc."

The alterations in design were in the direction of what is called a kinematic bearing, in which the restraining surfaces are never extensive, as they are in an ordinary journal bearing. The conventional V-bearing for the telescope trunnions, for example, has the necessary surfaces to restrict the motion of an axis; the surfaces of contact are small and do not require precise machining; they form a true kinematic bearing. The modifications made with the alidade axis of the Wild Universal Theodolite were to cut away metal until the bearing

surfaces were reduced to 3 mm. in width. The tests show the results of the alterations to have been extremely successful.

Some critics (*cf. Empire Survey Review*, vol. III, 16, 1935, p. 73, and 'Conference of Empire Surveyors,' 1935, pp. 41, 157) who do not themselves use or care for Wild theodolites have not been slow in making adverse deductions from these experiments. It should therefore be noted that it was simply a conviction of the intrinsic excellence of the Wild instruments which inspired these researches and alterations. Had the authors of the paper thought that more satisfactory theodolites for their purposes could otherwise be obtained, it is not likely that they would have gone to the great lengths, both practical and theoretical, which are implied in this paper. M. A. S

VARIATIONS OF LEVEL OF CASPIAN SEA

Information concerning variations of level of the Caspian Sea is given by Dr. W. Köppen in the *Annalen der Hydrographie und Maritimen Meteorologie* (1936, Heft 2). For the past the evidence is based on changes in the depths of navigable channels, on the disappearance or reappearance of islands and the submergence or re-emergence of stretches of the coast-line. Water-gauge records have been available since 1830, and these show an extreme variation of level during the past century of only 124 cms. This century appears to have been a period of lower water than any since the sixteenth century, and according to curves after Berg, Wosnessenskij and Rosen the sea stood about 3 metres higher during the eighteenth and early nineteenth centuries. Within the historic period however the level has probably never been more than 5 metres above the present, and statements to the effect that it has been as much as from 12 to 40 metres above are declared to rest on doubtful evidence.

Dr. Köppen considers there is no foundation for the assumption that the Caspian level has been affected by tectonic earth-moments, and that accordingly the variations of this inland sea have special meteorological significance. Meteorological testimony supports the inference that during the high-water period of the eighteenth century the Volga was carrying much more water to the Caspian than during the preceding and succeeding centuries. Reference is made to a map of the mouth of the Volga produced by Berg in 1925, indicating two erosion channels over 6 metres deep. These are believed to have been formed in a prehistoric period of hot dry summers when the Caspian Sea was very low. It is pointed out that soils, which during the last fifty years have been carefully investigated by the Russians, respond very tardily to changes of climate and that certain soils in the Caspian region indicate a warmer and drier climate than the vegetation now growing on them.

GEOMORPHOLOGY OF THE SOUTH DOWNS

A paper by Mr. A. J. Bull in the *Proceedings of the Geologists' Association* (vol. XLVII, 1936, Pt. 2), entitled "Studies in the Geomorphology of the South Downs (Eastbourne to the Arun Gap)," is of interest particularly in regard to the origin of the coombs which are so conspicuous a feature of the steep northward-facing scarp of the chalk. The origin is explained as somewhat similar to that of the rugged corries, which they closely resemble in shape, of Wales, the Lake District and the Highlands as well as of many mountain regions the world over, glaciated now or in the past. Since however there is no evidence that the Pleistocene ice-sheet spread south of the Thames the phenomena of the South Downs are ascribed to nivation as distinct from glaciation. During the glacial period the Downs were covered with snow for the greater part of the year. Masses of snow or névé resting in hollows would form a protective cover

for the floors whilst the walls were worked back by frost-action. The process has been modified by solution, and numerous gullies cut in the face of the escarpment from top to bottom indicate that water came from melting snow on the higher parts of the Downs. The Devil's Dyke is described as simply a channel cut by melt-water from a snow cap on the Downs, as indeed originally suggested by Mr. S. W. Wooldridge. There are other water-cut channels, headed by coombs, of the type of the Devil's Dyke, which does not run directly down the escarpment but winds round into it.

While the edge of the Downs is thus cut into a festoon-like arrangement of coombs, the dip-slope is covered with a branching dry valley system draining into the river gaps or towards the south. Founded on a mature pre-glacial drainage the dry valleys have been cut by running water from a copious snow and rainfall during periods when the chalk was saturated with water and repeatedly frozen. Drainage channels can be seen in some places which were probably cut during the last glacial period. The rounded forms of the downs were produced by solution accompanied by soil creep together with the formation of scarp drift during the warmer conditions of inter- and post-glacial times. It does not appear that underground solution has played any large part in denudation.

In brief the scenery of the South Downs is chiefly attributed to sculpturing under cold climatic conditions followed by the smoothing effect of gentle denudation under warmer conditions.

OBITUARY

DR. JEAN CHARCOT

In no country outside France was Jean Charcot more appreciated, in none more mourned than in our own. Some books and many papers have been written of his voyages, both North and South. Many explorers have been, and more will be, influenced by his experience and knowledge. These books and experiences are at the disposal of all.

It is not the purpose of this notice so much to write of his work in detail as to write something of the man himself. He was essentially a man of science in the broadest sense; by birth, for his father was one of the most distinguished neurologists of his day; by upbringing, for he studied for and in the medical profession; and by taste and use, for he was able to follow the line of thought presented by his own researches and bring such to a definite conclusion for the benefit of his fellow men. Modern youth may think that he came somewhat late to the career of a polar explorer, for he was thirty-five before he went on his first voyage to the South in the *Français* of 250 tons, with the intention of relieving the Swedish Antarctic Expedition under Otto Nordenskiöld, whose ship had been lost in the Weddell Sea. Nordenskiöld had been rescued and Charcot was able to devote two seasons to exploratory research work, first at the north end of the Biscoe Islands; then, after wintering at Wandel Island, going farther south, sighting Alexander Island and other parts of the continent, to which he gave the name Loubet Land.

It was however with the *Pourquoi Pas?* that his name and fame are most intimately connected. Those who knew Charcot intimately will recognize the

challenging, but half joking, spirit that such a name suggests. She was built for the purpose of polar travel. It is to be remarked that though the men of the *Français* had had hard times, for it is known that towards the end of her voyage they were pumping twenty-three hours out of the twenty-four and many were spitting blood from exhaustion and hardship, all wished to serve with Charcot again. In 1909, at the age of forty-two, he was again in the South, this time in the *Pourquoi Pas?* He was approximately the age at which Robert Scott went on his second expedition. Weather conditions were good; he was able to examine Adelaide Island closely. He concluded that through an error in longitude the Loubet Land of his first expedition was really Adelaide Island, and transferred the name of Loubet to the portion of Graham Land east of that island. He explored the southern end of the strait separating Adelaide Island from Graham Land and the great Marguerite Bay to the south and east. After visiting Deception Island, he again proceeded to the south-west, and on 11 January 1910, sighted to the south-west of Alexander Island some new land in latitude 70° S., to which he gave the name of Charcot Land, after his father. In addition to geographical discovery much scientific work was accomplished in these two expeditions, for which he received the Patron's Medal of our Society. On his return from this expedition Dr. Charcot was appointed Director of the "Laboratoire des Recherches Maritimes."

Then came the war. Charcot was forty-seven. He volunteered at once for service and joined the Frency Navy as a surgeon. He wished for more executive work, and in 1915 a Dépêche Ministérielle directed that he should be lent to the British Admiralty. With the rank of an auxiliary lieutenant in the French Navy he commanded, with a mixed crew of French and British, the *Meg* under the French flag in the anti-submarine flotilla at Dover.

His command of the English language, learned from the lips of an English nurse, polished and perfected by his own application, was complete, and it displays his sense of humour and proportion that he was completely successful in such a unique position. For these services he was awarded the Distinguished Service Cross. Ill health forced him on shore in 1916, but 1917 found him again afloat in command of a new French trawler, also named the *Meg*, and in this command he continued till the end of hostilities.

The war over he returned to his work of exploration and research in his old ship. Each year Greenland, Rockhall, and other places were the scenes of his activity, and in these years he made copious reports based on real and deep investigation. It was within these years that the youth of this country who follow that fascinating, if to some incomprehensible, occupation of Polar travel, found in Jean Charcot a master-mind, a friend and counsellor, to whom all could apply with the certainty of assistance.

His knowledge of English, before referred to, removed any difficulty of intimate communication. That was backed by a personality which had nothing in it but desire to give. He gave freely, kept nothing back. The difficulty was to drag one's self away from the charm of his conversation. His knowledge was at the disposal of all, conveyed with a mixture of depth and gaiety that was irresistible. Each in turn of our young explorers would go to Paris to gain from him some of the wealth of his experience. Mr. Rymill, now in the Antarctic, to mention only one, is deeply indebted to him.

No notice of Jean Charcot would be complete without a reference to his sense of fun. To hear him describe how he was told the method of treating a polar bear in the Antarctic or to listen to his advocacy of advanced politics to an old-fashioned traditionalist, was a delight.

Returning from Greenland last September he touched at Reykjavik. He

sailed from there at 1 p.m. on September 15 and met with a great gale in which at 5 a.m. the next morning his ship was forced on shore, under circumstances which we shall never know, and his crew of some forty men lost with but one survivor.

Charcot and twenty-two of his companions whose bodies were recovered were given a national funeral at Nôtre Dame and in the brilliant sunshine, with not a breath of wind, in the heart of their own country, Jean Charcot and his comrades, far from the tempest and blizzard that brought them to their death, were carried home. W. E. G.

Our Society was represented in Paris at the funeral by Admiral Sir William Goodenough. One speech only, delivered by M. Perrin, was made at that most impressive and representative gathering, but Admiral Goodenough left with M. Grandidier the following appreciation, for much of the French of which he was indebted to Mr. Angus Malcolm.

"C'est devant un homme qui s'est mis entièrement au service des autres que nous sommes venus nous incliner. À quiconque le demandait, à quiconque en avait besoin, Jean Charcot était à tout instant prêt à prodiguer ses grandes connaissances, son immense savoir. C'est un homme qui avait un jugement clair et précis, qui savait enregistrer avec exactitude et conter avec charme ce qu'il trouvait au cours de ses voyages. Aucun explorateur moderne des régions polaires ne songerait prendre le large sans avoir pleinement puisé dans cette vaste richesse. Nous aussi, citoyens de la Grande Bretagne, nous avons eu l'occasion de nous enrichir ainsi. La France peut être assurée que le nom de Jean Charcot est vénéré de tous ceux qui, comme lui, se vouent à la vraie Science. Je me rappelle avec fierté que Jean Charcot possédait la médaille d'or de la Société que j'ai l'honneur de représenter et comme ancien Officier de la Marine qui m'a chargé d'exprimer sa sympathie avec fierté, je me rappelle que lui aussi était un de mes Camarades. Nous partageons votre deuil et nous rendons hommage avec vous, à la mémoire d'un grand homme mort sur ce champ d'honneur qu'est la mer."

COLONEL G. F. A. WHITLOCK, C.B.E.

Colonel G. F. A. Whitlock, C.B.E., late R.E., who died at Ostend on 1 September 1936, at the age of sixty-eight, had spent a good deal of his active career in survey employment and had had a wide experience of that kind of work for which the corps to which he belonged offers many opportunities. He was born in 1868 and was commissioned in the Royal Engineers in 1887. He served on the Ordnance Survey from 1897 to 1903 and was noted as a very efficient division officer. His next employment was as Assistant-Commissioner on the Yola–Lake Chad Boundary Commission of 1903–4, under Lieut.-Colonel L. Jackson, now Major-General Sir Louis Jackson. He was from 1907 to 1909 British Commissioner on the Boundary Commission which delimited the greater part of the southern portion of that frontier, stretching from Yola southward to the Cross River, a very difficult region; during this delimitation some fighting with native tribes took place. From 1909, for four years, he was Chief Instructor in Surveying at Chatham. He then reverted to the Ordnance Survey and was in charge of the Irish Division, in Dublin, during the troubles of 1916, and managed to keep the Survey free from disturbance. Later he was the capable executive officer of the Ordnance Survey at Southampton. In

1919 he was appointed British Commissioner on the Inter-allied Boundary Commission for the delimitation of the German-Belgian frontier. He retired in 1922. A few years afterwards he was elected Mayor of the ancient borough of Barnstaple. He received the Murchison Award of this Society in 1916.

C. F. C.

CORRESPONDENCE

THE DOUBLY-EQUIDISTANT PROJECTION

In the *Geographical Journal* for June 1921 you published a note of mine on "A Doubly-Equidistant Projection," and in 1922 I described the same projection in Ordnance Survey *Professional Paper*, New Series, No. 5. I have now heard from Dr. Oswald Winkel, of Leipzig, that he has recently received a communication from Ministerialrat H. Maurer to the effect that the latter had already, in *Annalen der Hydrographie*, 1919, p. 77, published an account of the *Doppelabstandstreue Projektion*. I need not say that, when I wrote the note above alluded to, in 1921, I was in entire ignorance of the existence of Dr. Maurer's work on the same projection.

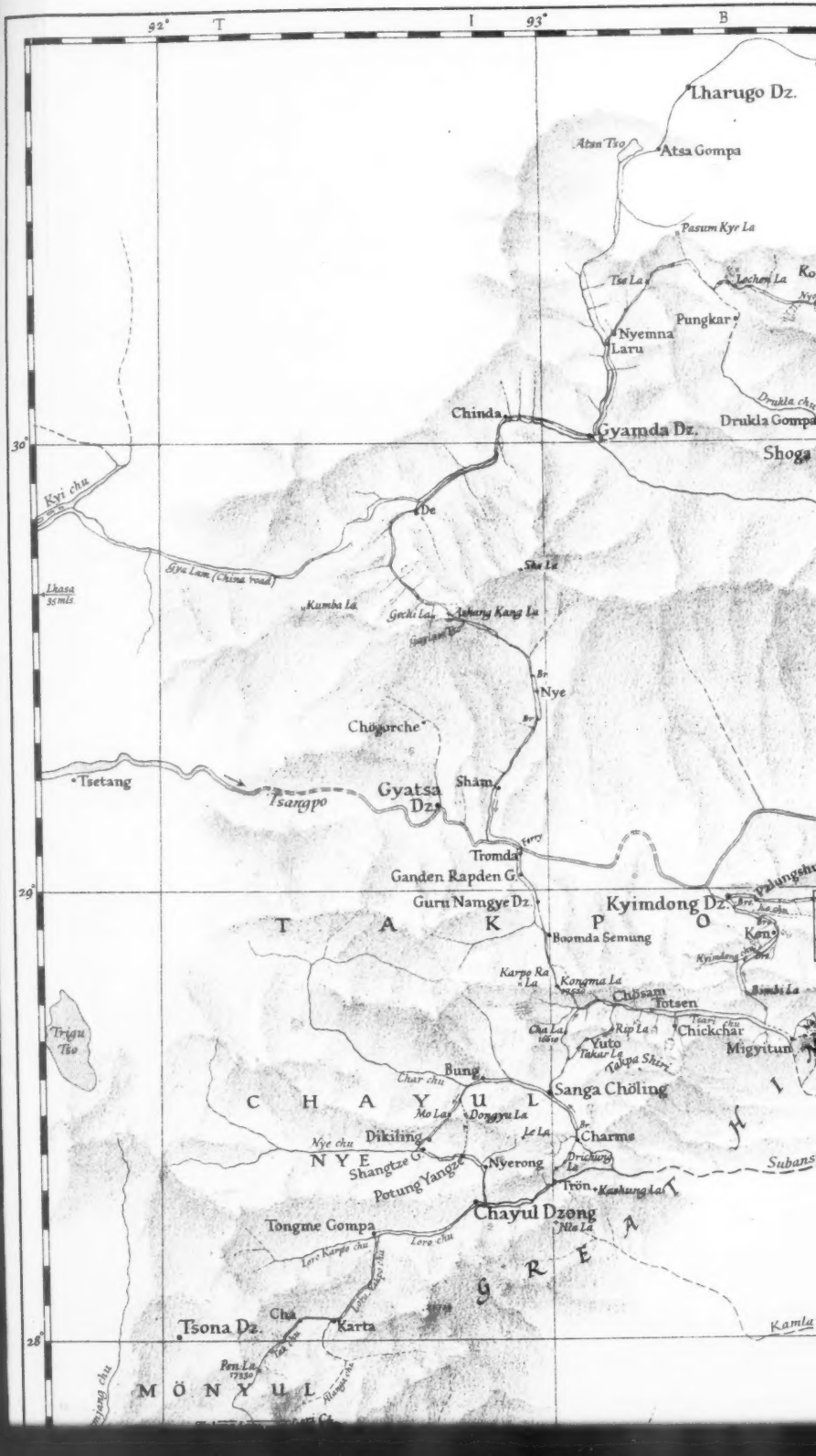
Perhaps I ought to add that the late Mr. A. E. Young, in a review of the O.S. *Professional Paper* No. 5, in the *Geographical Journal* for October 1922, remarked with reference to the Double Azimuthal Projection that "it is only right to mention that the possibility of such a projection was mentioned by M. J. I. Craig . . . at page 5 of his valuable work on 'The Theory of Map Projections,' published in Cairo in 1910." The Double Azimuthal Projection was described, and admirably worked out for the first time, by Dr. Maurer in the *Zeitschrift für Vermessungswesen* for 1 January 1922. He called it the "Orthodromic" Projection, and proved that all great circles are represented by straight lines. It is not at all likely that Dr. Maurer had seen Mr. Craig's remark above mentioned, and the present writer cannot remember having seen or heard of it until the late Mr. A. E. Young drew attention to it. But Mr. Craig must be credited with having been the first to think of this type of "double" projection.

Dr. Oswald Winkel is himself well known to us for his contributions to the study of Pseudo-Cylindrical Projections, notably in *Petermanns Mitteilungen* for 1921, where three "combined" projections are described. C. F. Close.

ERRATUM

Rasmussen Land: correction

We regret that in the list of his party given on p. 199 of Mr. A. Courtauld's paper in the September *Journal* the name of Mr. Ebbe Munck was by an error omitted.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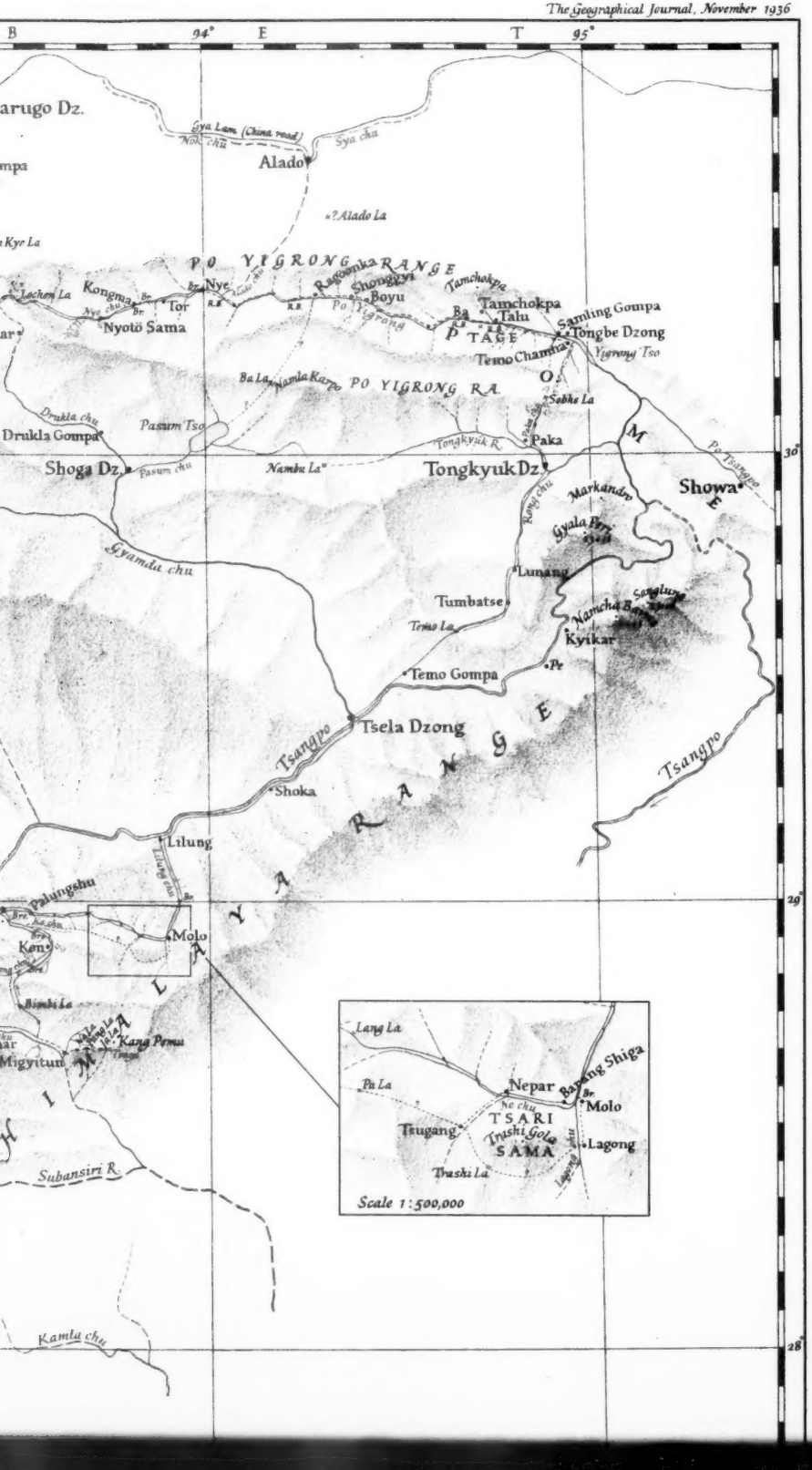
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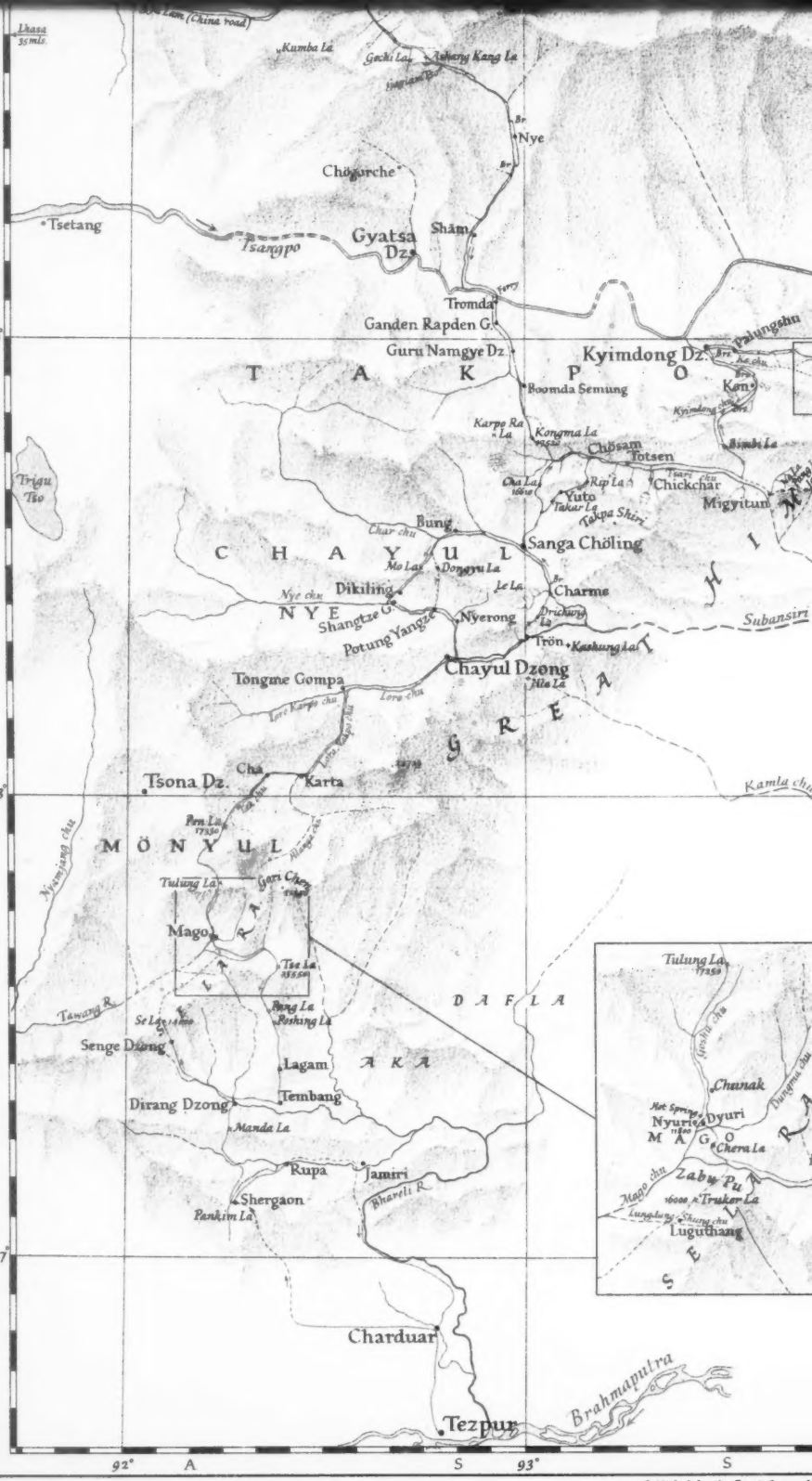

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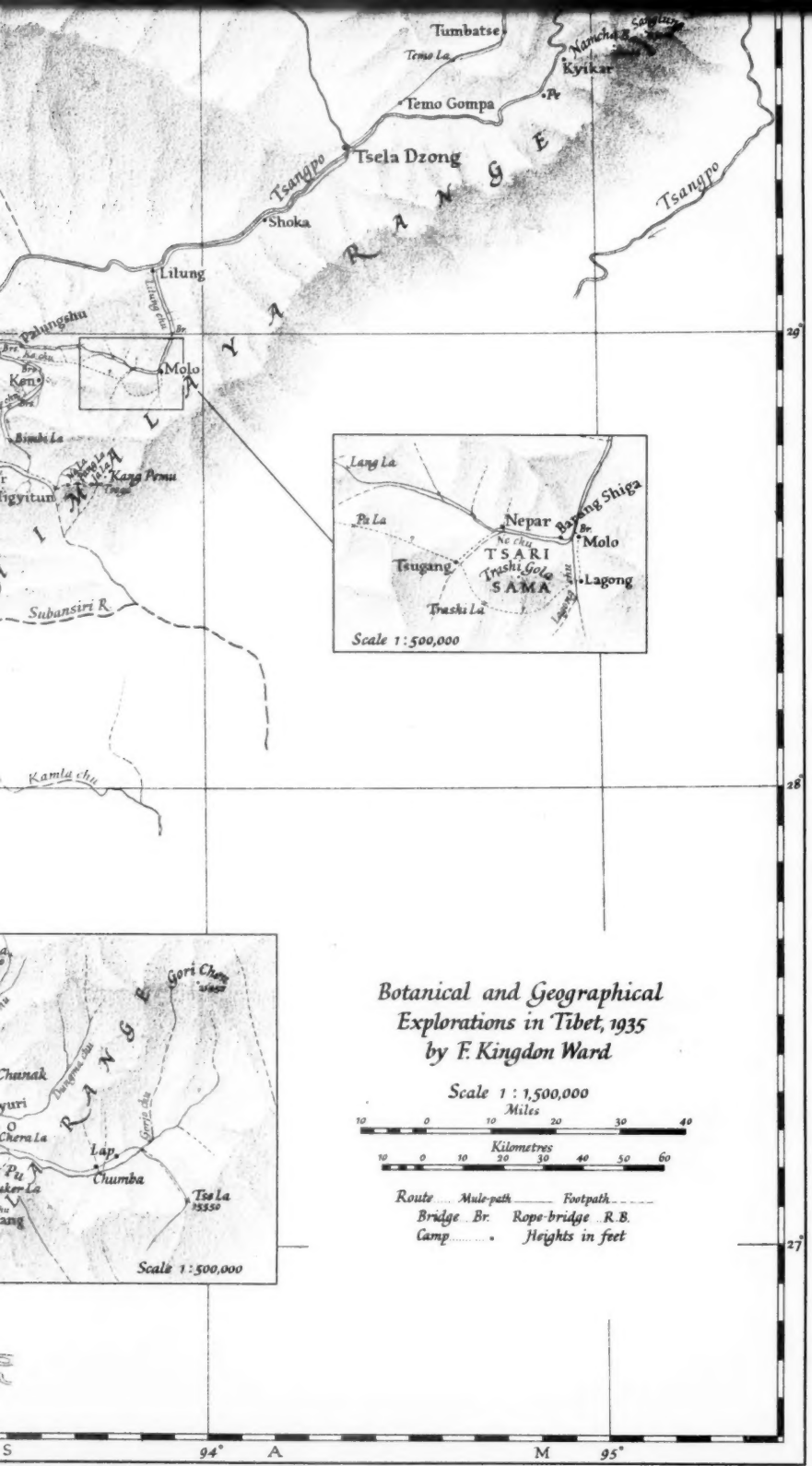

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